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A THIRD DIGEST OF THE LITERATURE ON DDT

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CONTENTS

CONTENTS (continued)

CONTENTS (continued)

This digest abstracts the articles included in the third list of publications on DDT (E-674). The literature referred to in the first and second lists of publications on DDT has been reviewed in the first (E-631) and second (E-687) digests. Nearly 1,000 publications dealing with DDT which had appeared up to July 1, 1945, are covered in these three digests.

DEFINITIONS

"The term 'DDT' refers to the technical grade of 2,2-bis(parachlorophenyl) 1,1,1-trichloroethane, which contains as impurities considerable amounts of isomers and much smaller amounts of other by-products formed in its manufacture. So far as we are now aware, the normal impurities in DDT are active ingredients within the meaning of the Insecticide Act of 1910. Therefore, its label is not required to bear an ingredient statement."--Reed (300).

It is recommended that in the future the term "p,p'-DDD" be used exclusively for reference to "2,2-bis-(p-chlorophenyl)-1,1-dichloroethane".--Gunther (195).

CHEMISTRY

Synthesis

The preparation of DDT in the laboratory is described in such a way that it can be performed as a regular experiment in the beginning course in organic chemistry. 45 grams (0.2 mole) of monochlorobenzene and 34 grams (slightly over 0.1 mole) of chloral hydrate are added to 350 grams of 95-percent sulfuric acid and 50 grams of 20-percent oleum; the mixture is stirred for 90 minutes, during which time the temperature rises to 45°C. The reaction mixture is poured into 2 liters of ice water and the solid product washed on a funnel under suction with cold water. The crude product is then melted in 500 ml. of boiling water, allowed to solidify by cooling, and the wash water removed by decantation. This process is repeated two additional times, and sodium bicarbonate is added to the last wash water to remove the last traces of acid. The product is then collected on a suction filter and dried. The yield of crude material (m.p. about 90°C.) is about 70 percent of theoretical. It can be purified by recrystallization from ethyl or propyl alcohol.--Darling (126).

The laboratory preparation of DDT according to Zeidler's procedure, using chloral hydrate instead of chloral, is described. The mixture is heated under a reflux condenser to 122°C. for 2½ to 3 hours, or is stirred with heating (not to exceed 105°) for 8 to 10 hours.--Bailes (80).

Physical properties

A procedure for determining the setting point of DDT is described.

A mixture containing 25 percent of p,p'-DDT and 75 percent of o,p'-DDT has the lowest setting point, namely 39.1°C. The setting point for a mixture containing 70 percent of p,p'-DDT is 86.5-87.2°, and for one containing 80 percent of p,p'-DDT 95.2°. A setting-point curve for mixtures of these two isomers is presented from which it is possible to ascertain the composition of any mixture from its setting point. The content of p,p'-DDT in technical DDT as indicated by the setting point checks well with that obtained by recrystallization from alcohol. The solubility of pure p,p'-DDT in alcohol at 30° is 1.6 gram per 100 ml. --Fleck and Preston (154). This procedure was adopted by the U. S. War and Navy Departments (357).

DDT crystallizes in the orthorhombic system and has a density of approximately 1. The powder X-ray diffraction pattern was determined. --Clark and Cagle (113).

Composition of technical DDT

Technical DDT, of setting point 88°C. as obtained in the Brothman continuous process, is of the following approximate composition:

	Percent		Percent
p,p'-Isomer (DDT).....	70	Unidentified solids...	2
o,p'-Isomer	18	Volatile material	1
o,o'-Isomer	6	Ash	1
"Oily by-product" (unidentified)	2		

A material of higher setting point would contain a greater percentage of actual DDT.--Gunther (195).

Attention is directed to the various isomers of DDT which may be present in variable proportions in different batches of material, and to the erroneous hypothesis that when DDT is dissolved in petroleum oil its surface tension is reduced.--Calif. Agr. Expt. Sta. (101).

Reactions of DDT

DDT prepared according to Zeidler's procedure was dehydrochlorinated by boiling in alcoholic potassium hydroxide; the resulting ethylene product (m.p. 86-87°C.) was oxidized with chromic acid in acetic acid to p,p'-dichlorobenzophenone, which establishes the position of the chlorines as p,p' in DDT. Several attempts to oxidize p,p'-DDT with chromic acid in acetic acid to p,p'-dichlorobenzophenone gave no identifiable products. 1,1-Di(p-chlorophenyl)-1,2,2,2-tetrachloroethane (m.p. 91-92°) is readily made by chlorination of the trichloroethane compound or the dichloroethylene derivative.--Grummitt et al. (190).

Di-(p-chlorophenyl)acetic acid (m.p. 163-164°C)was prepared by heating 1,1-di(p-chlorophenyl)2,2-dichloroethylene with alcoholic potassium hydroxide in a sealed Carius tube at 150-160° for 20 hours. --Grummitt et al. (191).

DDT is very sensitive to alkaline materials. It "dehydrohalogenates" upon heating slightly above its melting point. The technical grade, which contains appreciable quantities of the heat-sensitive o,p'-isomer, may begin to cleave hydrogen chloride at 50°C. At 80° a 90-percent loss of insecticidal efficacy occurs within 24 hours. The heat-induced decomposition of DDT appears to be autocatalytic, the liberated hydrogen chloride initiating further decomposition. In the absence of excessive temperatures, the primary decomposition product, DDD [meaning the ethylene derivative, also known as TDE - RCR] is more stable than the parent compound. Contrary to the early reports, under summer field conditions in southern California, where leaf temperatures may exceed 125°F. and fruit temperatures 135°, DDT was found to lose its residual effect very quickly. Usually 2 weeks was more than sufficient to eliminate toxic effects. Experiments performed under winter conditions, however, indicated little, if any, loss of toxicity over several months. These results, and similar reports from other investigators, suggest that ultraviolet energy, between 2875 and 3100 A. U., may be another catalyst for the dehydrohalogenation of DDT, although Garman and Townsend report that sun-lamp irradiation does not destroy the effectiveness of DDT as a dust. Light may break DDT down to p,p'-dichlorobenzophenone.--Gunther (195).

Gesarol AK-20 spray proved to be entirely compatible with wettable sulfur.--Conklin (116).

DDT is a rather stable compound. Long periods of exposure to the air have caused no appreciable change. Irradiation of the solid material, spread in a thin layer, for 35 hours with a 100-watt mercury-vapor lamp, lowered its melting point by only 2°C. Similarly, an alcoholic solution of pure DDT showed no change after exposure to sunlight for over a year. DDT in alcoholic solution is readily decomposed by alkalies to 2,2-bis(p-chlorophenyl)1,1-dichloroethylene, m.p. 88-89°. DDT was decomposed when heated with an equal weight of the following materials for 1 hour at 115-120°: Kaolin, fuller's earth, iron rust, ferric chloride, nicotine, and certain samples of talc and pyrophyllite. DDT was not decomposed when heated with calcium oxide, hydrated lime, or commercial lime-sulfur; and was only slightly decomposed (4 to 7 percent) when heated with bordeaux mixture or sulfur. Commercial grades of sodium fluoride, sodium fluosilicate, cryolite, paris green, calcium arsenate, and lead arsenate showed no catalytic activity in decomposing DDT. Likewise, pure rotenone and pyrethrum were found to be inactive. Dolomitic limestone was the only fertilizer tested which showed catalytic activity. Heating the mixture for 1 hour produced 0.89 mole of hydrochloric acid. The catalytic action persisted after the limestone had

been slurried with water and then dried at 110°C. This treatment would destroy the catalytic action if it were due to small traces of anhydrous ferric, aluminum, or chromic chloride. Most solvents inhibit the catalytic decomposition of DDT by anhydrous ferric chloride, exceptions being nitrobenzene and chlorobenzene. With o-dichlorobenzene the catalytic action occurred even at room temperature.--Fleck and Haller (153).

Analytical methods

A procedure for recovering organic chloride (DDT) spray deposits from apples consists in extracting 10 to 25 fruits with acetone or benzene and determining chlorine in the solution.--Fahey (148).

DDT spray deposits on fruit or other material are removed with benzene, inorganic chlorides are removed from this solution by extraction with several portions of water, the benzene is removed by evaporation, and the DDT is decomposed by refluxing with 1 N alcoholic potassium hydroxide for 30 minutes. The resulting potassium chloride is determined by titration. Recovery of known amounts of DDT by this method was 99.5 to 101 percent.--Gunther (194).

Instructions are given for the determination of labile chlorine, total chlorine, and DDT by the Schechter and Haller colorimetric procedure. The ratio of labile chlorine to total chlorine on seven samples of DDT-sprayed apples from experimental plots in the western, central, and eastern apple areas ranged from 0.192 to 0.216, which closely approximates the theoretical 0.200. Recovery experiments wherein DDT was added in amounts equivalent to 1-15 p.p.m. to benzene extracts of unsprayed apples indicate that the over-all error of chlorine methods (exclusive of the errors of sampling and sample preparation) is approximately ± 0.1 p.p.m. The errors at these levels affected the ratio of labile to total chlorine to the extent of about ± 0.01. If the deviation from theory is greater than this, the sample should be subjected to further investigation.--U. S. Food and Drug Administration (353).

A colorimetric method for the microdetermination of DDT is presented. The test is based on the discovery that, when DDT is heated in an anhydrous pyridine solution containing xanthydrol and solid potassium hydroxide, a red color develops, which under proper conditions is proportional to the amount of DDT present. The reaction is sensitive to as little as 10 micrograms of DDT. It will detect small differences in concentration within the range of 10 to 200 micrograms.--Stiff and Castillo (338).

Solvents for DDT

The addition of 15 percent of a special methylated naphthalene [Velsicol] to kerosene makes a solvent that holds DDT in solution at

temperatures as low as -20°F. The War Department's specifications for DDT spray have been revised to require the inclusion of this substance. --Anon. (33).

The solubilities of pure DDT, m.p. 107-108°C, in nine organic solvents (acetone, benzene, carbon tetrachloride, chloroform, dioxane, ether, ethanol (95%), petroleum ether (30-60°), and pyridine) at 0°, 7.2°, 24°, 45°, and 48°C. were determined. At all temperatures except 0°C. the solubility is greatest in pyridine, and at that temperature it is greatest in acetone. Benzene is the most efficient stripping solvent for pure DDT at room temperature.--Gunther (193).

Methylene chloride is an excellent solvent for DDT and can be used as an auxiliary solvent to make it more soluble in Freon-12 (dichlorodifluoromethane). Dimethyl ether and methyl chloride are good solvents for DDT.--Goodhue et al. (181).

The following solvents for DDT were used in tests upon houseflies and cockroaches: Deobase, acetone-Deobase, toluene, Deobase-mineral oil, and cyclohexanone.--Goddin and Swingle (179).

At room temperature the solubility of DDT in some of the common solvents is as follows:

Solvent	Grams per 100 ml.	Solvent	Grams per 100 ml.
Cyclohexanone	100 to 120	Kerosene, crude ..	5 to 8
Xylene	56	Kerosene, purified	2 to 4
Ether	29	Ethyl alcohol....	1.5
Diesel oil No. 2...	10		

Calif. Agr. Expt. Sta. (101).

EFFECT OF SOLVENTS FOR DDT ON ITS TOXICITY TO INSECTS

Laboratory tests conducted at Beltsville during the winter of 1944-1945 indicate that the nature of the solvents used with DDT has an important bearing on its toxicity. Some solvents, such as kerosene, evaporate quickly (a matter of minutes), leaving needlelike crystals that are very durable, the toxic effects lasting from 3 to 6 months under outdoor weathering. These tiny crystals may penetrate the footpads of the insects and possibly enter the pores in the sclerites of the body. Velsicol AR-50 (a mixture of mono- and di-methylnaphthalene) produces similar crystals, but these require a day or more to form. Heavy solvents, such as Diesel oil, remain tacky for days and leave a deposit that is not so persistent as that resulting from kerosene. On the other hand, these tacky or viscous films kill several times as quickly.--Craighead and Brown (125).

DDT FORMULATIONS

Chemically pure DDT melts at 108.5°-109°C. Two grades of commercial product are available——technical DDT, specified to have a setting point not lower than 88°; and DDT, purified, specified to have a melting point of at least 103°. The former has found use in louse powders, mosquito larvicides, and in general agricultural experimentation; the latter is intended for use in aerosol bombs. DDT has been used in water suspensions, solutions, emulsions, dusts, and aerosols. Water suspensions are divided into three classes (1) those resulting from the mixing of finely ground DDT (ground either dry or wet) with water, (2) those resulting from the dilution with water of a solution of DDT in a water-miscible organic solvent, and (3) those obtained by mixing diluents impregnated or coated with DDT with water. The preparation of these formulations is discussed.--Chisholm (112).

Gesarol AKZ-40 Spray is a powder containing 40 percent of DDT which is easily wettable and stable in water suspension. It has been designed particularly for use with Gesafloc spreader (a liquid soap spreader preparation) in the control of codling moth.--Geigy Co. (167).

Gesarol AK-40 Spray is a powder containing 40 percent of DDT. It is easily wettable and stable in water suspension.--Geigy Co. (168).

Gesarol A-20 Spray is a finely ground powder containing 20 percent of DDT. It is easily wettable and stable in water suspension, and contains an amount of wetting agent and sticker necessary for the recommended uses. Gesarol A-20 spray is designed for use on such hard to wet crops as onions, corn, and certain ornamentals and shade trees where good wetting or penetration of leaf-axils is required.--Geigy Co. (173).

The composition of some Geigy products tested in California is as follows:

GNB-A is "commercial pure" DDT
A3 is a 3 percent DDT dust
A-20 is 20 percent DDT with wetting agent
AK-20 is 20 percent DDT without wetting agent
SH-5 is 5 percent DDT in emulsive oil base
SH-20 is 20 percent DDT in emulsive oil base
SHN-20 is 20 percent DDT in nonemulsive oil base

.--Calif. Agr. Expt. Sta. (101).

Neocid Spray Deodorized contains 5 percent by weight of DDT in a deodorized kerosene base. It should be used undiluted as a residual-type spray in the control of flies, mosquitoes, bedbugs, fleas, silverfish, clothes moths, carpet beetles, ticks infesting buildings, cockroaches, poultry mites, and fowl ticks ("bluebugs").--Geigy Co. (172).

Neocid Barn Spray is a finely ground wettable powder containing 20 percent of DDT and a suitable quantity of a spreading and sticking agent. It may be used either as a residual-type spray against flies and adult mosquitoes or as a dip against cattle and goat lice and sheep ticks.--Geigy Co. (171).

Neocid A-10 Powder is a finely ground dusting powder containing 10 percent of DDT. It is designed for use without further dilution in the control of roaches, fleas, carpet beetles, bedbugs and other insects affecting man, poultry, and livestock.--Geigy Co. (170).

Gesarol Dust Concentrate contains 40 percent of DDT and is designed for dilution in ordinary dust-mixing equipment without additional grinding. Recommended diluents in the order of preference are (1) nonfibrous talcs of good dusting quality, (2) pyrophyllites of dusting grade, and (3) dusting clays, diatomaceous earths, calcium carbonate or chalk, gypsum, and fibrous talcs. Do not use hydrated lime, bentonites, or fuller's earth as diluents in the preparation of Gesarol dusts, as they seriously reduce the efficiency of the product. Certain organic fillers, such as walnut-shell flour, have a similar, though less serious, effect and are therefore not recommended.--Geigy Co. (169).

Unmodified DDT is not in suitable form for the consumer. The Army and Navy have about six products made to their specifications. DDT will be used in the form of dusts, solutions, aqueous suspensions, emulsions, and aerosols. For the conventional household fly spray, the recommendation is the addition of 0.2 percent of DDT with whatever reduction in present active ingredient can be tolerated to provide knock-down, since even this small quantity of DDT will give "kill." DDT formulations, which may be of many compositions and strengths, must be tried and proved to establish proper claims.--Jeneman (226).

Among the DDT insecticides authorized for supply by the U. S. War Department (25, 358) June 1945 were the following:

Insecticide, aerosol, 1-pound dispenser (3 percent DDT, 2 percent pyrethrum extract containing 20 percent pyrethrins, 5 percent cyclohexanone, 5 percent hydrocarbon oil and 85 percent Freon-12). The aerosol bombs are an olive-drab color affording easy differentiation from the black dispensers previously issued which contained pyrethrum, sesame oil, and Freon-12.

Insecticide, DDT emulsion concentrate (25 percent DDT, 10 percent emulsifier, 65 percent xylene). Stock mixture for making a 2-percent DDT emulsion to be used primarily in louseproofing clothing and to a limited extent for larviciding purposes.

Insecticide, spray DDT, residual effect (5 percent DDT, 15 percent solvent, and 80 percent kerosene). For use in killing flies, mosquitoes, roaches, bedbugs, ants, and other insects that

rest or crawl on treated surfaces. Should be applied only by trained personnel. May also be used to treat contents of pit latrines and to spray decomposing bodies and other organic material such as destroyed ration dumps.

Insecticide, liquid, finished spray (1 percent DDT, 2½ percent Thanite, in deodorized kerosene). For troop use spray directly on the insects or into the air in which the insects are flying (mess halls, barracks, etc.). Has no residual effect.

Insecticide, powder louse, 2-ounce can (10 percent DDT in pyrophyllite). Issued to individuals for use in eradicating and preventing louse infestation by applying to inner surface of underclothing.

Insecticide, powder, louse (10 percent DDT in pyrophyllite). For use primarily in mass delousing with power or hand dusters. May be used to control bedbugs, roaches, ants, and to treat habitats of fleas and mites.

Insecticide, spray, delousing (6 percent DDT, 68 percent benzyl, benzoate, 12 percent benzocaine, 14 percent Tween-80). Must be diluted 1 to 5 with water just prior to use. Kills both adults and eggs of body, head, and crab lice. Also an effective scabicide.

Larvicide, DDT, powder, dissolving (100 percent DDT, commercial grade). For dissolving in oil or other approved solvents to form solutions up to 5 percent DDT, for use as larvicides, residual sprays, and airplane sprays.

Larvicide, DDT, powder, dusting (10 percent DDT in talc). For use as a mosquito larvicide after diluting to make a 2 percent DDT mixture. Also for use as fly larvicide and roach powder without dilution. May be applied to habitats of fleas and mites.

The Crop Protection Institute during 1944 studied the relation of DDT to solvents and liquid carriers, and to various dry diluents. A large number of representative liquid carriers and more than 30 inert diluents for dust have been studied. From these investigations several formulations have been developed which are safe on plants and which permit DDT to perform to advantage.--O'Kane (277).

DDT is not in itself a complete insecticide, but is a toxicant which requires very careful compounding with other compatible substances to act as diluents or carriers.--Anon. (9).

Specifications

The U. S. War and Navy Departments (356, 357) have issued joint Army-Navy specifications covering DDT, both technical and aerosol grades.

PHARMACOLOGY

DDT was administered by mouth, subcutaneous injection, inhalation, and cutaneous application to mice, rats, guinea pigs, and rabbits. It was concluded that DDT insecticides should be considered as practically harmless to mammals, including man.--Domenjoz (135).

The use of an aerosol containing 1 to 5 percent of DDT, 10 percent of cyclohexanone,and 89 to 85 percent of Freon should offer no serious health hazards when used under conditions such as are required for its use as an insecticide. The use of DDT in concentrations up to 10 percent in inert powders for dusting clothes, as in the extermination of lice, appears to offer no serious hazards because of the relative insolubility of DDT and the large particle size of the dust. Therefore, it does not reach the alveolar spaces. A 1 percent DDT-Deobase mixture was found to be nontoxic to rabbits exposed for 48 minutes daily over a period of 4 weeks. Its use as a fly spray, which involves only temporary and comparatively moderate exposure to much lower concentrations, should be safe. However, owing to the fat-solvent properties of most petroleum distillates, irritation of the skin may follow heavy exposure.--Neal (273).

Two aerosol mixtures, containing 3 and 2.5 percent of DDT, were tested on guinea pigs, rats, mice, monkeys, and dogs. Monkeys exposed for 45 minutes daily to a single, initial concentration of 33.3 mg. of DDT per liter for 22 weeks and longer showed neither definite nervous symptoms characteristic of DDT nor signs of an injurious effect on the liver. For entomological purposes the initial concentratior of DDT in air, when used as an aerosol, is about 100 to 200 mg. per 1,000 cubic feet, corresponding to about 0.004 to 0.007 mg. per liter. In the inhalation experiments reported above, the initial concentration ranged from 19 to 33 mg. per liter, or 3,000 to 4,500 times the desired entomological concentration. It is evident, therefore, that the desired entomological concentration offers no health hazard. The contamination of the skin from such residues as are produced by the desired insecticidal concentration of DDT in air is so little that it will not injure humans. However, careless handling of DDT residues, as in the filling of the aerosol bombs, may result in such severe contamination of the skin, especially with repeated exposure, that toxic effects might occur in humans.--Neal et al. (272).

Aerosol No. 305, containing 2 percent of pyrethrum extract (20 percent pyrethrins), 3 percent of DDT (aerosol grade), 12 percent of APS-202 and 83 percent of Freon-12, was tested on mice, rats, and dogs. The

animals were placed in a hermetically sealed glass chamber of 409.7 liters capacity, a 1-pound aerosol cylinder was discharged into the closed chamber, and the animals were exposed to the resulting mist for 45 minutes daily, 6 days a week, for 1 month. Under these conditions APS-202 is not a primary skin irritant and, unlike Velsicol NR70, it is not photosensitive when applied to the skin. Aerosol No. 305 is no more toxic than No. 2730 (contains 3 percent of DDT), studied previously, and its use as an insecticide should not involve any hazards.--von Oettingen et al. (363).

In solid form DDT applied topically to the skin is nonirritating, nonsensitizing, and not appreciably absorbed. In solution, either in oil or in organic solvent, it readily penetrates the skin and is mildly irritating and sensitizing. In single and multiple dose administration (acute and subacute) there are wide individual as well as wide species variations. In prolonged feeding experiments (chronic toxicity) rats have been fed diets containing 100, 200, 400, 800 ppm. of DDT for about 18 months. Guinea pigs, dogs, and monkeys have been studied for shorter periods. The pharmacological manifestations of effect from DDT are principally loss of appetite, mild to severe tremors of central nervous system origin, convulsions, and death. Tremors can be prevented or abolished by general anesthetics and narcotics. Histopathologic examination of tissues of animals which have received DDT shows damage which is neither striking nor characteristic for all species.--Calvery (103).

DDT is cumulative in effect. "Whether this central nervous system effect is reversible we do not know. The tremors can be completely abolished by sedatives, and in my opinion if this is done that animal is recovered. But if it has gone on long enough to affect the internal organs, that may not be reversible. Except sedatives, there is no specific treatment for DDT poisoning."--Calvery (104).

Typical signs of DDT poisoning observed on mammals under laboratory control were lessened appetite with corresponding weight loss, nervousness, tremors, and in the final stage convulsions. The liver and thyroid may be affected and, after repeated application to the skin, a slight dermatitis may occur. The exposure to large doses of undiluted DDT in powdered form produced no symptoms of poisoning in animals with either intact or abraded skin. However, solutions of DDT in a nonirritant solvent such as dimethyl phthalate caused severe poisoning. No irritation was noted from powdered DDT on the hands of operators who had almost daily contact with it during the past year. A number of commercial preparations containing up to 5 percent of DDT have proved safe for limited use. The injunction of doses as low as 0.5 ml. of a 30 percent solution of DDT per kg. per day (150 mg. per kg. per day of DDT) to rabbits, rats, and guinea pigs may cause death in some cases after 30 days. Affected

animals became easy prey to secondary infections. The effects of DDT in experimental animals are cumulative; small single doses given repeatedly lead to chronic poisoning. In a group of 10 rats each weighing about 80 grams, DDT fed at a level of 0.1 percent in the diet was uniformly fatal in from 18 to 80 days. Generalized tremors were present throughout. At a level of 0.05 percent of DDT the animals survived 3 months, though there was some impairment of growth. In the study on rabbits a mild degree of anemia was evidenced by a reduction of the hemoglobin level. White blood cell counts however, failed to indicate significant deviations from the normal. The safe level in human foods cannot be over 10 p.p.m. "I, myself, would not risk more than 70 milligrams, or 1 mg. per kilogram."--Calvery (105).

Daily doses of oily solutions containing 10 percent of DDT were administered orally to dogs in the ratio of 100 mg. of the drug per kilogram of body weight until symptoms of intoxication appeared. In some cases slight symptoms were apparent after a few days, but the animals recovered promptly and spontaneously. It was only after new administrations of DDT that intense symptoms were observable. Spontaneous recovery occurred 12 to 24 hours after treatment. From then on the susceptibility of the animals to the drug increased greatly. To verify the effect of calcium on the development of the symptoms of poisoning, these animals were given doses of 150 to 200 mg. of DDT per kilogram of body weight. Calcium gluconate (10 percent solution) was injected intravenously to investigate its curative and preventive effects. "The satisfactory results obtained by the use of calcium gluconate in prevention and treatment of dogs experimentally intoxicated by DDT suggest that the apparent neurologic symptoms observed are consequent to hypocalcemia, and not due to direct action of the DDT upon the central nervous system." All but one of the six dogs used in these experiments was in apparently good physical condition a month after the experiments were ended.--Vaz et al. (361).

Beginning January 10, 1944, rats were kept on a diet containing 1 part of DDT in 10,000 parts of foodstuff. On March 11, just 2 months later, they began to have convulsions. Two days later half the rats were restored to normal food with near disappearance of convulsions. However, both the withdrawn rats and those remaining on the DDT diet died within the next 2 days. In May 1944, the Bureau of Entomology and Plant Quarantine fenced 3/4 acre of grassland containing grasshopper egg masses about 60 miles from San Diego, Calif. When the hoppers were emerging, the area was fairly effectively dusted at the rate of 40 pounds per acre with a 10-percent DDT dust. After 48 hours the California State Bureau of Chemistry was permitted to put 3 ewe sheep in the field. After 72 hours the sheep showed extreme neurologic symptoms, reminding one of dogs suffering from rabies. Nervous disorder in the sheep was characterized by tremors and especially by motion in the hind legs similar to stringhalt in horses. Their necks seemed to be affected, as they

would keep their noses to the ground but did not graze. The animals eventually recovered, probably due to removal of the DDT dust from the vegetation by wind, the tramping of the animals, and a slight rain. A month later the test was repeated. The animals behaved in the same manner as with the first treatment but again all recovered. One of the ewes was taken to the University of Southern California where the feeding experiment was continued. Beginning July 10, a dosage of 2 grams of DDT daily was administered orally by capsule for 11 days. No symptoms were noticeable and the dose was increased to 4 grams per day and continued for 40 days. On August 30 still no symptoms were noticeable and the dose was further increased to 8 grams daily for 14 days and then 16 grams daily; death ensued 17 days later. After the dosage was increased to 16 grams a day pronounced nervous symptoms in the form of tremors of the hind quarters and pawing with the forelegs were soon observable. These symptoms became more pronounced until the animal was unable to rise from the ground and stand on all four legs or manage itself. Upon autopsy the kidneys and liver showed moderate degeneration.--Cox (121).

A 5-percent solution of DDT in olive oil was given by stomach tube to rabbits. Crystalline DDT was isolated from the urine and feces.--Stohlman (339).

The presence of DDT in rabbit urine could not be verified by X-ray diffraction analyses but the metabolite di(p-chlorophenyl) acetic acid was isolated.--White and Sweeney (372).

Organic chlorine can be demonstrated in the urine of rabbits, cats, and dogs receiving DDT long in advance of any recognizable symptoms of poisoning. Experiments on the circulatory and respiratory responses to some typical drugs and to nerve stimulation in advanced DDT poisoning in cats indicate little deviation from the normal except for a lowered irritability of the peripheral vagi. Studies on the action of a series of hypnotics and related compounds in acute DDT poisoning in rats indicate good antidotal effects from urethane and to a lesser degree from dilantin.--Smith and Stohlman (326).

The ethoxy analog of DDT appeared less toxic than DDT when fed to white rats.--Prill et al. (297).

DDT in a 1-percent solution in liquid paraffin or olive oil showed very little effect against notoedric mange on rats. In a 2-percent solution, it led to the death of some of the experimental rats after the development of marked hyperaesthesia and frequent clonic muscular spasms. --Taylor (343). In a later report Taylor (344) stated:

> "One of the rats that had been dressed with 1 percent DDT in liquid paraffin developed symptoms of intoxication within 24 hours and died. Two other rats were subsequently dressed with a 10-percent

solution in the same way and developed the same symptoms, which took the form of a hyperaesthesia increasing in intensity until any sudden noise or movement was sufficient to induce generalised clonic spasms, which became continuous in the later stages and led to the death of the rats."

The author ate two or three bunches of sound grapes and peeled peaches that had been sprayed with DDT, with no bad effects in either case.--Bromley (96).

EFFECT OF DDT ON PLANTS

Tomatoes, potatoes, cabbage, turnips, onions, beans, peas, and tobacco are tolerant to low strengths and reasonable dosages of DDT dusts, but some injury to squash or other cucurbits may be expected.--White (373).

A 10-percent solution of DDT in cyclohexanone and light petroleum oil was sprayed in two areas at the rates of 6 and 4 pounds per acre. Neither dosage caused any apparent injury on coniferous trees, but the foliage of deciduous trees showed injury which varied according to the species, as noted:

Species	Foliage Injury
Speckled alder, Alnus incana	Medium marginal, some spotting
Aspen, Populus tremuloides	Medium spotting
Gray birch, Betula populifolia	Slight spotting
White birch, Betula papyrifera	do.
Yellow birch, Betula lutea	do.
Black cherry, Prunus serotina	Light marginal
Chokecherry, Prunus virginiana	Severe marginal
Pin cherry, Prunus pennsylvanica	Light to medium marginal
Hazel, Corylus sp.	Slight spotting
Mountain maple, Acer spicatum	Medium marginal
Red maple, Acer rubrum	Medium marginal and spotting
Nannyberry, Viburnum lentago	Light to medium marginal
Serviceberry, Amelanchier canadensis	do.
Willow, Salix sp.	do.

Bracken, raspberry, blueberry, strawberry, and wild honeysuckle suffered light to medium foliage injury.--Ross (306).

Most of the trees and plants on which DDT was used have not shown evidence of injury. On some apple trees, however, there was some yellowing and dropping of foliage, but an increase in mite abundance was largely, if not wholly, responsible. In experiments with soil treatments for Japanese beetle grubs, 25 pounds of DDT per acre definitely retarded the growth of bush beans, lima beans, soybeans, hollyhock, onions, spinach, and tomatoes. Some of the bean leaves became yellow, and tomato plants

were somewhat distorted. Higher strengths caused some growth retardation in beets, carrots, muskmelons, and potatoes. Tests are under way in which excessive quantities of DDT were applied to the soil under apple and peach trees, to simulate the accumulation that might occur over a period of years if DDT should come into general use. Thus far no injury has become evident.--Baker and Porter (81).

Radishes grown in soil containing 250 pounds of DDT per acre, thoroughly washed, and then fed to three-fourths grown larvae of the white fringed beetle (Pantomorus leucoloma Boh.) caused no mortality in 33 days. Germination of cotton, corn, peanut, oat, and cowpea seeds was not affected by treating them with a 50 percent DDT dust before planting. Austrian winter peas, peanuts, rice, sweetpotato, white potato, cotton, corn, cowpea, soybean, radish, and blue lupine have been grown in soil treated with various dosages of DDT up to 100 pounds per acre, and in some cases up to 250 pounds per acre, without visible injury. On the other hand, injury to young rye plants, consisting of reddening of foliage, twisting of leaves, poor growth, and dying of some plants, occurred in pot and field-plot tests in which DDT in dust or emulsified form was used as a soil insecticide at rates of 10 to 250 pounds per acre. Emulsions caused very pronounced injury even at the 10-pound dosage. The injury caused by the dust treatments was slight at the 10-pound dosage but increased with the dosage.--Packard (285).

Eight applications of 5 percent DDT in light summer spray oil, average about ½ gallon per acre, made by hand atomizer from June 6 to August 1, did not injure strawberries, asparagus, muskmelons, mangels, onions, kale, broccoli, cabbage, eggplant, squash, cucumber, peas, lettuce, turnips, tomatoes, carrots, beets, corn, beans, lima beans, or potatoes. On soybeans (Bansii) there was definite burn, which was probably due to the oil.--Gray (188).

The germination of rice seed was not materially affected by suspensions of 0.1 to 100 p.p.m. of DDT. Growth of microorganisms common to soil was not significantly affected by water suspension of 10 and 100 p.p.m. of DDT. Soil pretreated with a DDT-oil emulsion (5 percent DDT and 0.5 percent emulsifier in No. 2 Diesel fuel oil applied at the rate of 1 part to 20 million parts of water) supported growth of rice and barley comparable with that produced on similar untreated soil.--Broyer (97).

Apple. A moderate amount of foliage spot-type burn followed the fourth application of DDT in oil (2 oz. per 100 gal.) on Delicious, but not on Jonathan or Hubbardson. No similar injury was produced by lead or by oil-nicotine sprays on comparable trees in the same orchard.--Cleveland (114).

Gesarol AK-20 spray in repeated applications caused no perceptible injury to apple foliage or fruit.--Conklin (116).

Aside from some browning of the foliage late in the fall, there was no apparent injury from any of the DDT sprays or dusts tested.--Anon. (17).

Citrus. In none of the field experiments made with DDT, either dissolved in oil or used in other ways, was the slightest indication found of injury to the trees. Four navel orange and four lemon trees were sprayed seven times from March to December 1944 with each of the following treatments: (1) 1 3/4 percent of light medium oil, (2) 1 3/4 percent of light medium oil with 4 percent of DDT in the oil, (3) 3 percent of kerosene, (4) 3 percent of kerosene with 4 percent of DDT in the kerosene, and (5) Gesarol AK-20 at 10 pounds to 100 gallons of water. The repeated light medium oil sprays caused serious defoliation and dead wood on the 14-year old orange trees but little damage to the 5-year old lemon trees. In neither case, however, was the damage greater on the oil-DDT-sprayed trees than on the oil-sprayed trees. Neither the kerosene nor the kerosene-DDT caused any discernible injury to either the orange or the lemon trees. Likewise, no injury to the bark below the soil line was observed when the soil was removed and the trunks were scraped on February 8, 1945. The repeated treatments with Gesarol AK-20 also caused no deleterious effects.--Ebeling (142).

Corn. A 3-percent DDT dust interfered with growth of the corn.--N. J. Agr. Expt. Sta. (275).

Grape. DDT-pyrophyllite (20-80) was used at the rate of 1 pound of DDT in 100 gallons of water plus ½ pound of soybean flour. The spray was applied at the rate of 200 gallons per acre on July 15 and 27. The entire vineyard was treated with the DDT spray on August 9. Most of the spray was directed toward the upper surface of the leaves to avoid spraying the fruit. There was no injury from DDT sprays to foliage.--N. J. Agr. Expt. Sta. (275).

Peach. Three applications of 2 pounds of Gesarol A-20 per 100 gallons caused no damage to peach foliage.--Underhill (349).

Pear. Dormant miscible oil containing DDT, applied as a dormant spray to give 5.12 ounces of DDT per 100 gallons, caused no adverse effect on buds, bloom, foliage, yield, or fruit size.--Cleveland (114).

Potato. No harmful effects on foliage were noted. In one test DDT-treated potato plants appeared more vigorous, larger, and darker green than those treated with other materials. Early blight lesions were not significantly reduced with DDT.--Tate et al. (342).

Squash. Heavy applications of 2-percent DDT dust at weekly intervals killed squash plants.--Underhill (349).

Young squash and pumpkin plants were severely stunted and young cucumber plants were stunted to some extent by a 3-percent DDT dust. The acorn squash was more susceptible than any of the other varieties. --Tate et al. (342).

A 10-percent DDT dust injured squash plants.--Haseman (203).

Wheat. Dosages as high as 0.2 percent by weight of technical DDT showed no injurious effects on the viability of seed wheat containing 12 percent of moisture. The treated samples of wheat were examined once a month for 4 months.--Cotton et al. (120).

Effect of DDT on Fungi

DDT at 3/4 pound per 100 gallons of water was not effective as a fungicide for early blight of potatoes.--Heuberger (207).

DDT is not a fungicide.--Horsfall (214).

DDT SPRAY RESIDUES AND THEIR REMOVAL

DDT tolerance on foods

A formal tolerance of 7 mg. per kilogram for fluorine on apples and pears has been announced. An informal tolerance of 7 mg. per kilogram for lead on apples and pears has been recognized for several years. "In view of the agreement among the toxicologists concerning the quantitative relationship of the toxicity of DDT to that of lead and fluorine, this [Food and Drug] Administration has concluded that during the coming year it will not be its purpose to inaugurate regulatory action against commodities containing 7 mg./kg. or less of DDT."--Dunbar (140)

[1 p.p.m. = 0.007 gr./lb. and conversely,
0.01 gr./lb. = 1.42857 + p.p.m.] -RCR

Suggestions are presented on the use of DDT on various food crops so as to avoid a DDT residue of 7 p.p.m. or more.--Geigy Co. (174).

Residues on fruits and vegetables

At Winchester, Va., Stayman Winesap apples that had received 5 applications of DDT at the rate of 1 pound per 100 gallons of water (4 pounds of 25 percent DDT in third to seventh covers) bore a residue of 0.042 grain of DDT per pound. Washing with 1.3 percent of hydrochloric acid reduced the residue to 0.037 grain per pound; washing with

sodium silicate 75 pounds and soap 1 pound per 100 gallons reduced it to 0.027 grain per pound; washing with trisodium phosphate 10 pounds per 100 gallons reduced it to 0.034 grain per pound; and brushing in a Trescott machine left the residue at 0.041 grain per pound.--Hough (217).

Preliminary tests at Vincennes, Ind., indicated that DDT residues on apples may be difficult to remove by either brush machines or flotation-type washers. Soaps, oils, wetting agents, and strong alkaline solutions had little effect, and none removed as much as half the residue. Similar tests at Yakima, Wash., confirmed these results. A maximum of approximately 60 percent of the DDT spray residue was removed by using 2 percent of oil in water followed by a wash in a wetting agent to remove the residual oil.--Baker and Porter (81).

Two ounces of DDT per 100 gallons of oil, applied 4 times to July 17, produced 0.0040 grain of DDT per pound on harvested Delicious apples, and 0.0045 grain per pound on Hubbardsons.--Cleveland (114).

Washing tests indicate that it is difficult to remove DDT spray residues from apples and pears. Solvents commonly used for the removal of arsenical residues have no action on the DDT. Kerosene and heavier petroleum oils dissolve the DDT residue but redeposit it evenly in the oil film that remains on the fruit as it leaves the machine. Detergents appear to show greatest promise for removing DDT residues. In commercial washers the most effective results were obtained when apples or pears were processed in an overhead food machine, in which water (95°F.) containing a wetting agent such as Vatsol or Triton 720 was used. Residues of 0.111 grain of DDT per pound on apples were reduced to 0.047 grain. Apples with 0.06 grain per pound were cleaned to 0.035 grain. Pears, however, that carried 0.042 grain per pound were cleaned only to 0.037 grain. When the wetting agents were added either to acid or to sodium silicate, similar results were obtained. Silicate may prove more effective for cleaning apples after they become waxy in storage.--Childs and Robinson (111).

DDT residues on apples from experimental plots were as follows: Two samples from the Pacific Northwest, 2 and 7 p.p.m.; three samples from the Middle West, 5 p.p.m. each; and two samples from the East 4.5 and 6 p.p.m.--U. S. Food and Drug Admin. (353).

DDT sticks to apples much tighter than does lead arsenate and is, therefore more difficult to remove. Apparently it goes into solution in the waxy covering of the apple. To remove the DDT it is almost necessary to take the wax off the apple. On the other hand, DDT does not build up so heavy a residue on apples as lead arsenate or the other insecticides used. Three or four applications can be made without building up a serious residue.--Annand (74).

Analyses of pea pods and kernels from plots treated with DDT indicated the presence of DDT on the pods, but its absence on the kernels. The amount of DDT present on the pods was proportional to the percentage of DDT used.--Lange (241).

Eight applications of 5 percent DDT in light summer spray oil--average about ⅛ gallon per acre--were made to various vegetables (¼ acre) by hand atomizer from June 6 to August 1. The kale was fed to chickens from June throughout the summer and all the vegetables were consumed by the family and others, with no ill effects. The DDT residue on the beans (Blue Lake) at the time they were canned was 0.029 grain per pound. No other residue analysis was made.--Gray (188).

DDT residue on fruits, vegetables, alfalfa, and olive foliage and fruit was determined by extracting with benzene and dehydrochlorinating with alcoholic sodium hydroxide. Alfalfa treated twice with 3-percent DDT dust at the rate of 28 pounds per acre-application bore a DDT residue of 29 p.p.m. (fresh weight). Bartlett pears sprayed with 5 pounds of A-20 per 100 gallons of water bore DDT residues of 0.5 to 3.7 p.p.m. On pears sprayed with 2½ quarts of SH-20 per 100 gallons of water the DDT residues ranged from 1.7 to 6.1 p.p.m. The DDT residues on some products were as follows: On walnuts, 13 and 43 micrograms per square inch of surface after 1 and 2 sprays containing 5 pounds of 20-percent wettable DDT powder per 100 gallons of water; on small green tomatoes 8 p.p.m., and on ripe tomatoes, average weight 50 grams, not over 0.5 p.p.m. after 4 sprays containing 5 pounds of 20-percent wettable DDT powder plus 6 ounces of blood albumin per 100 gallons of water.

Weathering of DDT residues

Field tests conducted during the past summer have indicated that DDT deposits on plants do not have the residual action anticipated as a result of tests on household insects. Deposits have been reported effective over a period of months in indoor tests, but under outdoor conditions they generally have remained effective for not more than 14 to 18 days. This was found to be the case in certain tests with the Japanese beetle on linden trees, with cabbage caterpillars on cabbage, and with the codling moth on apple. Apparently some factors in the outdoor environment decompose the DDT or remove it from the foliage. Moisture and sunlight are generally considered the two most important factors in outdoor weathering, but it is possible that heat may be a factor on the upper surface of foliage. Tests to determine the action of sunlight on the toxicity of DDT residues were not successful because of extensive periods of cloudy weather. After a few preliminary trials it seemed more practical to expose sprayed glass plates to an ultraviolet lamp so that different exposure periods could be used. It was recognized, of course, that this type of radiation is only a fraction of the spectrum of sunlight, but it was felt that some preliminary information of value might be obtained. The ultraviolet source was a

30-watt, germicidal lamp giving a wave length of 2,537 angstrom units, which is a wave length normally filtered out of sunlight by the earth's atmosphere. Recrystallized DDT (s.p. 108°C.), as well as several samples of plant-run material (s.p. 84-90°C.), was deposited on glass plates from acetone solutions and aqueous dispersions prepared by different methods. After exposure to ultraviolet light for various periods, each plate was introduced into a cage containing house flies in such a way that all flies could and did contact the plate. Treated plates that were unexposed to the light affected the flies in 10-15 minutes, but exposure to ultraviolet rays caused a loss in toxicity in proportion to the exposure. Residues of DDT deposited from solutions could be rendered nontoxic to flies by a 3-day exposure to this lamp. There seemed to be no difference in the three samples with regard to loss of toxicity, but there was some difference between the compositions used. The presence of the inert material in the dispersible compositions seemed to retard the rate of decomposition below that occuring with residues from solutions, and, in general, the smaller the particle size the more rapid was the rate of decomposition. This apparent decomposition of DDT as a result of exposure to light is of great interest and importance with regard to the residue problem. It is possible that weathered residues may have little or no toxicity to man and domestic animals.--Goddin and Swingle (179).

EFFECT OF DDT ON WILDLIFE

The danger of DDT upsetting the balance of nature is emphasized. --Teale (345).

An anonymous (31) writer called attention to Teale's article and deplored the idea of a world free of insects. DDT will prove a valuable boon in many ways but it can be an extremely dangerous boomerang unless proper precautions are taken.--Conant (115).

An editorial quotes Teale and Pough on the dangers to beneficial insects and birds from the widespread and indiscriminate use of DDT.--Anon. (56).

The 40-acre watershed of a small reservoir in Pittston, Pa., was treated at the rate of 5 pounds of DDT in 5 gallons of oil per acre. Three days later, after 0.75 inch of rain had fallen, an analysis of water samples from the reservoir indicated less than 1 part of DDT in 100

million parts of water. In the same area limited observations were made on the effect of DDT on forest fauna in general. There was no evidence of mortality of bird life, but some of the fish and bullfrogs in the reservoir were killed. Most species of insects were greatly reduced in number, but 3 days after the spray had been applied enough specimens of most species remained to repopulate the area.--Dowden et al. (136); Craighead and Brown (125).

In Canada one 8-acre area was sprayed by autogiro with a solution containing 10 percent of DDT in cyclohexanone and light petroleum oil at the rate of 6 pounds of DDT per acre. Another area of the same size was similarly sprayed but at the rate of 4 pounds of DDT per acre. Very little significant difference of effects was noticed between the two areas. Along the lake shores and in quiet pools a few minnows were killed by contact with the oil film when they broke through the surface to feed upon insects brought down by the spray. In the stream the emulsified DDT solution became too diluted to be toxic to minnows or speckled trout. However, speckled trout seem to be more sensitive to DDT, as any that fed on poisoned insect larvae and adults falling into the stream were killed. Aquatic insect larvae that remain submerged in quiet waters were not affected by the DDT spray. However, mosquito larvae and such surface forms as water striders and whirligig beetles were readily killed. In the streams, where the solution becomes mixed with the running water, or lodges under partly submerged rocks, the larvae and nymphs of aquatic insects, such as the dragon fly, damsel fly, may fly, caddis fly, stonefly, midge, cranefly, blackfly, beetle larvae (Dytiscidae, Psephenidae), and fishfly (Sialidae) may be completely eliminated. Crayfish and tadpoles were readily killed by contact with the spray or by ingesting contaminated food. As these are important sources of fish food, their destruction would no doubt have an unfavorable influence on fish survival within the streams. Clams, snails, and leeches were not affected by the sprays. The cyclohexanone and the oils used in the sprays were not in themselves toxic.--Ross (306).

In field experiments with DDT mosquito larvicides, DDT in concentrations sufficiently high to kill subsurface feeding larvae was toxic to the following three species of fish:

Black Bass.--A spray of diluted kerosene emulsion containing 0.1 percent of DDT proved fatal within 3 days after application.

Catfish.--In a pond sprayed with diluted oil emulsion containing 0.2 percent of DDT many catfish were dead 2 days after treatment.

Salt-water minnows.--Dead fish were found in salt-marsh test holes 2 days after treatment with a colloidal solution of 1 part DDT to 4,000,000 parts of water.

DDT was most toxic to goldfish when in colloidal dispersion, less toxic as a surface application in the form of an oil emulsion, and least toxic when applied as a dust. In each case, however, the toxicity was sufficiently high to warrant caution against the use of DDT on mosquito breeding waters where fish that are worth preserving prevail. DDT also killed water snakes, turtles, toads, and many species of aquatic insects. Aquatic plants or land vegetation growing near the treated water areas showed no injury when they were sprayed or dusted with the DDT larvicides.--Ginsburg (178); N. J. Agr. Expt. Sta. (275).

In Connecticut a DDT spray applied to sweet grapes (New York Muscats) did not protect them against orioles and blue jays which consumed all the crop not protected by muslin.--Bromley (96).

In Maryland 117 acres of the Patuxent Wildlife Refuge were doused with DDT mixed in an oil solvent and sprayed from an airplane. Experts of the Bureau of Entomology and Plant Quarantine (Department of Agriculture) and the Fish and Wildlife Service (Department of Interior) predicted that every insect in the area would be killed. But of more importance, they hoped to learn what quantity of the deadly DDT could be used for pest control without upsetting the delicate balance of wildlife. Careless use of DDT on mosquitoes, for example, might eliminate ducks and geese. Preparations for the experiment started almost 2 years ago. The location of every bird's nest, anthill, and mouse hole in the area was noted. Trays were placed to catch the dead insects; small animals were trapped in boxes. Stretches of the Patuxent River were netted off and fish counted. The experiment will continue for another year before results are known. Surviving life in the treated area will then be compared with census figures for untreated control areas. Adding incentive to the experiment is the widely held belief that post-war air traffic will bring multitudes of foreign insect pests.--Anon. (57) and Birchfield (84).

Fish and Wildlife Service observers will be present this summer at large-scale experiments in Pennsylvania and Maryland and in the Province of Ontario, Canada. Additional laboratory experiments as to the effect of DDT on various species of animals are underway at the wildlife research laboratory at Patuxent.--Anon. (55).

"DDT has been found to be highly toxic to bees, both as a contact insecticide and as a stomach poison. If DDT ever comes into general use as an insecticide, it conceivably might upset the balance of natural conditions by destroying the pollinators that produce a majority of our food crops. Agricultural practices should be regulated to prevent the destruction of bees and other pollinators."--Anon. (43).

PRODUCTION

United States

The Pennsylvania Salt Manufacturing Co., Philadelphia, Pa., announced on February 14, 1945, that it had completed installation of facilities for the manufacture of DDT on a commercial scale and that production had begun.--Anon. (21).

DDT was being made early this year by 13 producers and production must now [March, 1945] be close to 2,500,000 pounds monthly as compared with the starting output of 1,000 pounds in April 1943.--Stenerson (336).

At present [April 1945] United States is producing more than thirty million pounds of DDT per year, practically all of which is being used by the armed forces in one form or another. Unless wide insect control projects are developed in the postwar period, normal consumption of DDT for regular civilian uses is estimated to be a small fraction of this tonnage.--Peaker (291).

The DuPont Company first made DDT at an experimental plant at Cleveland, Ohio, and the first lot, 500 pounds, was shipped overseas shortly after American troops landed in Italy.--Anon. (38).

Sweden

In March 1945 commercial production of DDT was to be taken up by the A/B Mo och Domsjö at its Domsjö plant.--Anon. (37).

DDT, introduced into Sweden in 1943 as Gesarol, has been used principally for plant protection, although experiments are under way to develop products for veterinary and human use. Between 60 and 80 tons were consumed in 1944, both of the Swiss type and the cheaper Swedish type.--Anon. (59).

ALLOCATION

The War Production Board relinquished all control over DDT in September 1945 but it is of interest to review the situation during the time covered by this digest (January-June, 1945). According to a statement issued January, 1945, by the U. S. Department of Agriculture, the armed services will need all available DDT. For many agricultural pests suitable insecticidal mixtures and dosages have not yet been worked out and possible harmful effects of DDT insecticides on soils and plants are not fully known.--Anon. (12).

On February 12 the War Production Board announced that a limited quantity of DDT could be obtained directly from suppliers without direct

WPB authorization. DDT producers have been instructed by the WPB, however, in distributing the chemical to give consideration to work carried out under the supervision of experienced investigators, aimed at determining the suitability of DDT for agricultural and other civilian uses.--Anon. (20).

In February 1945 WPB emphasized to the DDT Producers Industry Advisory Committee that DDT will be released exclusively for experimental and research purposes, and that placement of orders for other insecticides should not be based on the supposition that DDT will be available for commercial use in 1945.--Anon. (18, 29).

DDT is scheduled for large-scale government tests and a limited amount will be available for civilian experiments this year.--Anon. (22) in February 1945.

The War Production Board holds the view that the total production of DDT over the balance of the year will be required exclusively for military uses.--Anon. (28), in March 1945.

Small amounts of DDT have been made available by WPB for experimental use in agriculture and other civilian fields. Production, which is increasing, is channeled for government use at present (March 1945). --Anon. (34, 36).

DDT civilian allocations, which will be limited to research and experimental work, now are controlled by War Production Board through Paragraph F, General Allocation Order M-300. To be eligible, experiments should be supervised by competently trained and experienced investigators, WPB announces. Other eligibility factors are "the type of experimentation proposed and whether it will contribute to the knowledge and development of the use of DDT, including (a) chemical and physical characteristics, (b) pharmacology, (c) toxicology, (d) compatibility with other materials, and (e) formulation of insecticides." Prospective experimenters will be allocated a stated amount of material. The producer then may go ahead and supply the DDT, but WPB emphasizes that "where a large quantity is requested, careful scrutiny should be exercised to see whether appropriate and adequate checks are to be maintained. The results of these large-scale tests should be recorded and appraised by competently trained investigators." The producers' allocations are for material to be distributed between February 15 and May 15, 1945.--AIF Assoc. (67).

On March 26, 1945, it was announced that release of DDT for general use in agriculture was unlikely in the near future. Tests with DDT against more than 170 different species of insects prove it to be definitely more effective than other insecticides currently used for control of some 30 pests; against 18 other insects, DDT insecticides were about equal to those ordinarily used, and against 14 important destructive pests, including the boll weevil, they were found to have little or no

effect. The performance of DDT insecticides is outstanding against certain pests, but is not a cure-all or panacea for all insect problems.--OPD Washington Bureau (282).

War Production Board is reiterating its warning that DDT released to civilians this year is solely for experimentation. Nevertheless, a WPB spokesman reveals "several instances where it would appear that efforts have been made to interpret the regulation to cover more than purely experimental programs." He adds that "in our efforts to continue to justify quantities of material for agricultural experiment (which must be taken from military supplies) we must have the assurance that the real intent of regulations is being observed. If DDT released for experimental purposes is used otherwise, it is contrary to regulations and may require the attention of our Compliance Division. --AIF Assoc. (68).

Additional small amounts of DDT, the war-developed insect killer, may be made available for agricultural and civilian experimentation during the last half of the year, the Chemicals Bureau of the War Production Board stated. At the present time [April 1945] blanket quantities of DDT are being released by producers for distribution to persons, firms, or government agencies engaged in research or experimentation directed toward the eventual use of the insect killing chemical in commercial pest control. Only trained and experienced investigators are allowed supplies for such work, WPB emphasized. WPB warned the industry that if DDT leaks out for any but strictly experimental work, complete allocation control of the chemical may be necessary, requiring considerably more paper work by both the government and industry. --Anon. (44).

The first approved commercial use of DDT was announced May 29 by Chemicals Bureau of WPB. Upon request of War Food Administration a limited supply of technical grade DDT has been made available in Oregon only for use against the potato tuber flea beetle. Rotenone, ordinarily used for this purpose in combination with calcium arsenate, is not available, and there are no other effective substitute materials for this purpose.--Anon. (58); also U. S. WPB (359).

At the December 1944 meeting of the California USDA War Board Economic Poisons Advisory Committee, it was the unanimous opinion that requests for DDT for pest control purposes should be allotted through economic poisons' registrants who have adequate facilities to carry on the difficult grinding and other procedures to prepare dusts and sprays, and who agree to use adequate safeguards. The Committee readily endorses the quantities needed to continue reputable experimental and pilot development work, and desires to encourage conservatism until experimental work has been completed.

For those instances where it is accepted that there is not too great a hazard, there should be a backlog allotment of DDT for use in California in case other pest control materials are not available for specific purposes. Suggested backlog amounts as indicated to be allocated for use as needed were estimated as follows:

	Pounds
Grape leafhopper on grapes before blooming	100,000
Citrus thrips on citrus	20,000
Codling moth on walnuts	10,000
Onion thrips on onions	50,000
Cankerworms on prunes	10,000
Worms on vegetable seed crops grown for seed (not including onions)	15,000
Thrips on dry beans	15,000
Protection of animals from pests, including spraying dairy barns to reduce flies	25,000
Experimental purposes	50,000

Pear thrips infestations are reported to have been extensive in 6 or 8 counties of California for the past 2 years and a backlog of at least an additional 110,000 pounds for this purpose would seem reasonable and desirable. Therefore, California agriculture could use approximately 400,000 pounds or more of DDT in 1945.--Cox (121).

COST

Early lots of DDT cost the government $1.60 a pound, later $1.00, and effective January 1, 1945 Du Pont announced a price of 60 cents.--Peaker (289); also Anon. (8) and Stenerson (335).

Transportation regulations

The U. S. Interstate Commerce Commission in April 1945 issued list CFR 73 revising the transportation rule on DDT, classifying the material as poison B, applying sections 352 and 361 on exemptions and packing, requiring a poison label, and setting a 200-pound maximum for shipment by express. On June 29, 1945 the Commission issued an order in Docket No. 3666 which removed DDT from the regulation, because as a result of an investigation by the U. S. Public Health Service it has been determined that this material is not sufficiently poisonous to be considered a class B poison under the regulations.--U. S. Interstate Com. Commis. (355).

PATENTS AND TRADE-MARKS

Patents

On April 20, 1943 Canadian patent 411,926 covering a devitalizing composition was granted Paul Muller (267). This patent is similar to

U. S. patent 2,329,074, covering DDT and analogous compounds granted September 7, 1943 to Muller and assigned to J. R. Geigy A. G., Basel, Switzerland.

On August 25, 1942 Belgian patent 446,935 was granted E. Merck (255). This patent covers insecticides consisting of diphenylethanes or diphenylethylenes of the general formula $(RR'X)C-C-(X'Cl_2)$, where R and R' are phenyl or substituted phenyl radicals, and X and X' are hydrogen or chlorine or are eliminated with formation of a double bond between the two aliphatic carbon atoms. In January 1945, it was reported that Geigy Company, Inc., New York, were negotiating agreements for licensing of insecticide firms under U. S. Patent No. 2,329,074, which covers the sale of DDT-containing insecticides. The licenses are nonexclusive and nontransferable, and besides involving a royalty payment of 5 percent of the net sales price also provide that any improvements developed in the use and application of DDT insecticides by the licensor shall become the property of the Geigy Company.--Anon. (5).

Trade-Marks

The Monsanto Chemical Company announced on March 20, 1945 that it would market DDT under the name "Santobane" and if formulations of DDT are produced the same term will be used and with it an identifying letter or number. At present Monsanto makes only the basic chemical. Volume production was begun September 1944.--Anon. (42).

The following symbols and names have been used to designate DDT or compositions containing it: GNB, GNB-A, GNB-A-DDT, Anofex, DeDeTane, DeDiTox, Gesarol, Guesarol, Gesapon, Guesapon, Gesarex, Guesarex, Gyron, Ixodex, Neocid, and Neocidol. The composition of these is given.--Roark (302).

Some of the preparations containing DDT used in Sweden are Alitox, Boxol, and Rotoxol.--Ahlberg and Mathlein (69).

DDT IN AEROSOLS

At the Virginia Truck Experiment Station DDT gave excellent control of the larvae of the diamondback moth on kale, collards, and broccoli when applied in a very fine mist in combination with methyl chloride and oil in a form commonly referred to as an aerosol.--Walker (365).

Aerosols produced by heat

Fog generators, invented to screen allied troops, ships, and military installations in World War II, are being used to disperse DDT over

fields, orchards, and vineyards. In 15 seconds to 2½ minutes an acre is blanketed with an odorless, impalpable but opaque mist, harmless to man and all other warm-blooded animals, that destroys every injurious insect. A complete kill of citrus thrips, grape leafhoppers, flea beetles, cabbage loopers, and three or four other troublesome pests can be reported without reservation. Cattle and barns are freed of flies by this very fine fog. The cost is trifling and the application incredibly easy and swift. The fog is made by feeding DDT in oil solution into a current of steam. The machine is made by the Todd Shipyards Corp. of New York City. A report of tests of a DDT-oil fog in the Salt River Valley, Ariz.--Anon. (49); also Vorhies and Wehrle (364).

Toxicology of DDT aerosols

Reports on this subject are given in the section on PHARMACOLOGY by Neal (272, 273), and von Oettingen et al. (363).

USE OF DDT BY PEST CONTROL OPERATORS

Since the general public lacks special knowledge of insects and control materials and procedures, it seems logical to expect that the pest control operator will be called upon to an increasing extent to undertake this work. Therefore he should endeavor to keep informed of developments from research on DDT insecticides.--Twinn (347).

Pest control operators should have no fear that DDT will put them out of business.--Anon. (27); (15).

At the third annual Canadian Pest Control Operators' conference at the University of Montreal, February 20, 1945, a program of cooperative research on DDT by the Canadian Department of Agriculture and the Canadian Pest Control Operators' Association similar to that in operation in the United States was discussed.--Anon. (46).

At the ninth annual Pest Control Operators' conference held at Purdue University, January 15-19, 1945, Maj. Franklin Sherman of the U. S. Army Sanitary Corps, reported on the decontamination of enemy territory before our troops set foot upon it. In the Philippine campaign the island of Leyte was covered with DDT before the invasion commenced.--Anon. (15).

REVIEWS AND POPULAR ARTICLES

Reviews of information on DDT have been published by:

Anon. (13), Bishopp (86), Buxton (100), Cox (123), Heilbron (205), Wasicky and Unti (367) and West and Campbell (369).

Some of the popular accounts of DDT are by:

Anon. (1, 32, 38, 39, 40, 45, 48); Anon. (51); AIF (63); Ananda Rau(72); Armagnac (76); Ayars (79); Baldwin Labs. (82); Bishopp (85); Callan (102); Cardoso (106, 107); Chapman (109); Childs (110); Cooper (117); Cox (121); Daviault (127); Dove (138) Essig (143, 144); Frey (161); Funk (163); George (177); Goodhue (180); Hall (197); Hambidge (198, 199); Kircher (235); Klumpp and Rice (237); Knowlton (238); McClintock and Fisher (250); McNeill (251); Mallis (252); Michelbacher (256); Morgan (265); Norris (276); Peede (292); Pope (295); Pritchard (298); Reed (299); Rohlf (304); Ross (307); Sealy-Fisher (310); Severin (312); Simmons (317, 318); Stafford (328); Stark (332); Tate (341); Twinn (347); Umhauer (348); White (371); Whitney (374); Wolman (380).

Brief mention of DDT is made by:

Anon. (7, 10, 14, 24, 52, 54); AIF (64); Auchter (77, 78); Borden (89); Cory (118); Davis (128); Degering (132); Kirk (236); Markwood (253); Meleney (254); OPD Observer (281); Patterson (288); Schifferes (309); Smith (323); Stage (329).

A chemist named Philippe Auerbach claims to be the inventor of DDT powder.--United Press (350).

Holland (213) has given a popular account of the aerosol bomb and the use of DDT in it.

INSECTICIDAL VALUE

The publications abstracted in this digest record the results of tests with DDT preparations on 325 identified species of insects and other arthropods belonging to 18 orders and sub-orders, 99 families, and 220 genera. There is no relationship apparent between the classification of the insect and its susceptibility to DDT. Sometimes different species in the same genus, e.g. the pepper and boll weevils, react differently to the same formulation of DDT. As a matter of convenience in handling a large mass of data the generic names of the insects are arranged alphabetically under the family names which in turn are arranged alphabetically under the order or suborder. These larger groups are arranged according to increasing complexity of structure—Orthoptera, Coleoptera, Lepidoptera, Hymenoptera, etc.

NEMATODA

Anguillulidae

Anguilluline dipsaci = Dipylenchus dipsaci filipius (Kuhn) Filipjev, the onion eelworm

A single application of 10 liters of water containing 2 percent of "Guesarol" and 0.2 percent of Tinopol oil per square meter is very effective in sterilizing eelworm-infested soil. Guesarol is a powder containing 5 percent of DDT.--Geigy Colour Co., Ltd. (166).

THYSANURA

Lepismatidae

Lepisma saccharina L., the silverfish

Spraying with refined odorless kerosene containing 5 percent of DDT killed silverfish in a wheat-sample room and the first floor of a flour mill, and the residual effect of the spray caused the death of invading silverfish for many weeks after treatment. In another test, two 100-pound cotton bags, one treated by dipping in a 5-percent solution of DDT in carbon tetrachloride and the other untreated, were filled with flour and stored next to each other in a mill basement. In a few hours the untreated bag was literally covered with silverfish, while not a single insect was observed on the treated bag.--Cotton et al. (120).

DDT residues in buildings sprayed with kerosene-benzene solutions containing 3, 4, or 5 percent of DDT killed silverfish.--Ross (306).

Tests on silverfish have not been satisfactory in experiments where conditions have not been well controlled.--N. J. Agr. Expt. Sta. (275).

Silverfish succumbed to Gesarol A-3 dust when their runways and trails were dusted.--Parker (287).

Thermobia domestic Pack., the firebrat

Deobase sprays containing 0.2 percent of DDT, together with pyrethrum or other paralytic agent as used for houseflies, gave excellent control of

firebrats when it was atomized into a Peet-Grady chamber. A talc dust depositing 20 mg. of DDT per square foot, or a Deobase-mineral oil spray leaving a residue of 80 mg. per square foot, gave complete control of firebrats confined on treated surfaces for 24 hours. Residues (80 mg. per sq. ft.) deposited from solutions in Deobase, cyclohexanone, or toluene, and those from aqueous suspensions, killed the insects, but more slowly than dusts.--Goddin and Swingle (179).

ORTHOPTERA

Acrididae

Camnula pellucida (Scudd.), the clear-winged grasshopper

DDT dusts and sprays gave good results.--Packard (285).

Melanoplus bivittatus (Say), the two-striped grasshopper

See M. mexicanus.--Parker (286); Packard (285).

Melanoplus differentialis (Thos.), the differential grasshopper

A 3-percent DDT dust (A-3) gave no indication of being toxic to differential grasshoppers when lightly dusted on them. The grasshoppers were swept from alfalfa and held in an insect net with alfalfa cuttings over night.--Smith (324).

A heavy infestation of grasshoppers in an alfalfa field treated with a 3-percent DDT dust at the rate of approximately 28 pounds per acre did not appear to be affected.--Michelbacher et al. (257).

Melanoplus femur-rubrum (Deg.), the red-legged grasshopper

In dusts cevadine was more toxic than veratridine and both were more toxic than DDT.--AIF (66).

See M. mexicanus.--Parker (286); Packard (285).

M. mexicanus (Sauss.), the lesser migratory grasshopper

The dominant species of grasshoppers present in plots treated with DDT were Melanoplus mexicanus (Sauss.), M. bivittatus (Say), and M. femur-rubrum (Deg.). No differences could be detected in their reaction to DDT dusts. The effects of DDT were apparent within half an hour after dusting. The grasshoppers became excited, descended from vegetation, and wandered aimlessly about manifesting distress. Many were down on their sides within 3 or 4 hours, but few were found dead the first day. In 48

hours the great majority were either dead or moved only feebly when disturbed. Grasshoppers were highly susceptible to DDT in dusts, sprays, and aerosols. Twenty pounds per acre of 15 percent of DDT in pyrophyllite applied either as a dust or spray reduced heavy infestations of grasshoppers to noneconomic numbers without injury to foliage. Unless washed off by heavy rains, DDT applied as a spray continued to kill over a period of several weeks, and in this respect was more effective than dust, which was removed by either wind or rain. Both sprays and dusts exhibited marked repellent effect. Sprayed or dusted plots of 1/2 acre or more, on which grasshoppers had been reduced to several per square yard, remained very lightly infested for several weeks although surrounded by infestations of 10 to 25 grasshoppers per square yard. No trace of foliage injury from DDT was noted at any of the dosages used. Fair to good mortality of grasshoppers was obtained from a single application, at the rate of about 20 pounds per acre, of a bait mixture containing the following proportions: 3 pounds of powdered technical DDT, 100 pounds of wheat bran, 1 gallon of molasses, and 1-1/2 gallons of water.--Parker (286); Packard (285).

DDT, at the rate of 16 ounces in acetone solution dispersed with soap per 100 imperial gallons of water, apparently had little effect either as a contact or a stomach poison in a test at Vernon, B. C.--Ross (306).

Unidentified grasshoppers

A 10 percent DDT-pyrophyllite dust reduced the population of grasshoppers in an alfalfa field.--Lieberman (245).

A 1 percent DDT-kaolin dust proved ineffective against grasshoppers. --Sen (311).

Blattidae

Blatta orientalis L., the oriental cockroach

DDT is a contact poison.--Domenjoz (135).

Blattella germanica (L.), the German cockroach

DDT was tested in October and November, 1943, and found to give good results at dilutions of 10 and 25 percent. In 1944 two commercial mixtures, Gesarol A3 with 3 percent of DDT and Gesarol A20, a spray material in powdered form, with 20 percent of DDT, were tested. The 20-percent mixture gave good results, whereas the 3-percent material was not satis-

factory. In all tests with this chemical the roaches were down in 12 hours or less, but in many instances were still actively kicking at the end of the tests (96 hours). When adult roaches were treated in a dust settling chamber with the army louse powder (10 percent DDT) 100 percent of both males and females were killed in 96 hours. The survival time in hours was 5.2 for males and 17.5 for females. Lethane A-70 roach powder likewise killed 100 percent of both males and females but the survival times were shorter, namely 2.4 hours for males and 7.0 hours for females.--Gould (183).

Laboratory tests with 3, 10, and 25 percent DDT dusts were conducted against the German cockroach in a settling dust chamber. The 3-percent dust gave poor results on both sexes. The 10-percent dust gave a 93-percent kill of males in 30 hours and a 66-percent kill of females in 55 hours, while the 25-percent dust gave 100-percent kill of males and a 98-percent kill of females in the same lengths of time.--Gould (184).

Deobase sprays containing 0.2 percent of DDT, combined with either pyrethrum, butyl carbitol thiocyanate, or bornyl thiocyanoacetate were found to be relatively ineffective when used in the Peet-Grady chamber against young nymphs of the German cockroach. When Deobase solutions of DDT were sprayed directly on the insects, dilutions down to 0.75 percent of DDT killed 100 percent of the roaches in 24 hours, but lower dilutions did not give complete control. Certain types of surface deposits of DDT were found to be very effective against roaches walking over them. Residues of from 4 to 40 mg. of DDT per square foot deposited by the evaporation of toluene solutions caused no mortality within 24 hours, but a deposit of 20 mg. of DDT per square foot, deposited as talc dust, killed 100 percent of the roaches. An 80 mg. deposit of sodium fluoride was required to cause a mortality of 92 percent. A deposit of 80 mg. of DDT laid down by the evaporation of a solution in Deobase-mineral oil gave complete control of young roaches. Less effective residues were obtained using DDT solutions in Deobase, cyclohexanone, or toluene, and also from aqueous sprays of a water-dispersible powder. These results indicate that dust deposits of DDT may be much more effective for controlling cockroaches than residues deposited from solutions or suspensions.--Goddin and Swingle (179).

An apartment adjacent to a store was infested with German roaches. Cockroaches were completely eliminated from the apartment by blowing a 20 percent DDT-talc dust into all cracks and crevices beneath the linoleum and between flooring wherever openings occurred. Other tests with 3 percent of DDT in kerosene against cockroaches were not satisfactory.--N. J. Agr. Expt. Sta. (275).

Not affected by a deposit of DDT on filter paper during 6 days.--Vargas and Colorado Iris (360).

Periplaneta americana (L.), the American cockroach

This roach succumbed to Gesarol A-3 dust when its runways and trails were dusted.--Parker (287).

Unidentified species

All the common household roaches, except the German roaches, are easily controlled. Either a 10-percent DDT dust used along the areas generally traversed by roaches, or a kerosene spray containing 5 percent of DDT heavily applied, is the most effective means of control. A 25-percent dust or repeated applications of the 5-percent kerosene spray will eventually make some inroads on the German roach. For practical purposes, however, there is little to be gained by substituting DDT preparations for the orthodox treatment with sodium fluoride, particularly for the German roach.--Freeborn (160).

A 10-percent DDT dust controlled roaches.--Haseman (203).

Cockroaches appear to be somewhat resistant to DDT, at least in the form of 5 to 10 percent dust. It seems that they are also rather resistant to the films that are left on sprayed surfaces. Several reports indicate a great reduction, but not complete extermination, of cockroaches of several species. Busvine, for instance, sprayed a bakery infested with Blatta, putting down a film estimated at 100 to 150 mg. per square foot. Those insects which were hit during the spraying died, but there were many live ones running on the film a week later.--Buxton (100).

Gryllidae

Acheta (= Gryllus) assimilis (F.), the field cricket

Acheta domesticus L., the house cricket

Apparently killed by DDT residual sprays.--Ross (306).

The field cricket was very abundant on many of the plots and was more susceptible to DDT than grasshoppers. In one instance, where there was a light drift of 15-percent DDT dust from a treated plot to an adjoining field, dead crickets were found 150 feet beyond the plot.--Parker (286).

Mantidae

Stagmomantis sp., a praying mantis

Individual praying mantis placed on sheets of paper dusted with a 1 percent DDT-kaolin powder and covered with a beaker were totally paralyzed in 50 to 70 minutes and dead in 600 to 650 minutes.--Sen (311).

DERMAPTERA

Forficulidae

Forficula auricularia L., European earwig

Twelve adults were placed in a cloth cage, the inside of which was lightly dusted with Gesarol A-3 dust (3 percent DDT), and complete mortality resulted within 24 hours.--Ross (306).

ISOPTERA

Armadillididae

Armadillidium vulgare (Latr.), sowbugs

In a laboratory test sowbugs placed in glass jars with a bait of DDT-rye flour (1-9) were all killed in 5 days. In comparison paris green caused complete mortality in 4 hours.--Ross (306).

Rhinotermitidae

Termites

Preliminary work at Asheville, N. C., and Beltsville, Md., indicates that DDT is very toxic to termites, both as a soil poison and in treated wood. In the latter case, however, it is of limited value because it has no fungicidal properties. Tests with fiberboard are under way in the tropics. Fabrics treated with 5-percent solutions of DDT have been resistant to termite attacks, and tests with lower concentrations are now being conducted. Fabrics treated with DDT were severely damaged by mildew and decay.--Craighead and Brown (125).

MALLOPHAGA

Menoponidae

Eomenacanthus stramineus (Nitz.), the chicken body louse

DDT in concentrations up to 10 percent (Neocid A-5 ard A-10) did not afford an experimental bird any better protection against the chicken

body louse than sodium fluoride, the standard treatment. A 3-percent DDT concentration (Gesarol A-3) was not so effective as sodium fluoride. The DDT did not protect the bird from reinfestation after 2 or 3 weeks, which is the approximate life cycle of the louse. Where all birds of a flock were treated, both the 3 percent DDT and the sodium fluoride seemed to give fairly effective control of lice.--Parker (287).

Trichodectidae

Bovicola bovis (L.), the cattle biting-louse

Three yearling steers heavily infested with lice were treated with a 10 percent DDT-pyrophyllite dust. In 24 hours all the lice had been destroyed; 3 weeks later a light infestation of recently hatched lice was observed and after 5 weeks the infestation had disappeared completely.--Munro and Knapp (269).

Trichodectes pilosum Giebel

Trichodectes scalaris Nitzsch

DDT is a contact poison.--Domenjoz (135).

THYSANOPTERA

Thripidae

Frankliniella fusca (Hinds), the tobacco thrips

At Beltsville, Md., seven applications of a 2 percent DDT-pyrophyllite dust were made at 3- to 8-day intervals to one series of plots, eight applications of a spray containing 0.66 percent of DDT, obtained by mixing a 10 percent DDT-pyrophyllite dust with water and a small percentage of spreader, at 4- to 6-day intervals to another series, and eight applications of an aerosol containing 10 percent of DDT, at 4- to 6-day intervals, to a third series. Good control of the thrips and decided increases in yield resulted from all these treatments, with no evidence of injury to the plants.--Packard (285).

See Thrips tabaci.--Loftin (247).

Frankliniella helianthi (Moult.), a flower thrips

There was some indication that 1.2 percent of DDT in oil applied as a vapo-spray was effective against thrips on peas.--Lange (241).

Frankliniella occidentalis (Perg.), the western flower thrips

Same as for Thrips tabaci.--Smith (324).

Hercinothrips fasciatus (Perg.), the bean thrips

Both living and dead thrips were present in an insect net with alfalfa cuttings that had been lightly dusted with 3-percent DDT dust (A-3) and kept over night.--Smith (324).

Hercinothrips femoralis (Reut.), the banded greenhouse thrips

In greenhouse tests 100 percent control was obtained with 8 ounces of DDT in a powder suspension and with 5 ounces in an acetone suspension per 100 imperial gallons of water.--Ross (306).

Scirtothrips citri (Moult.), the citrus thrips

In preliminary tests DDT gave favorable results.--Baker and Porter (81).

The value of DDT for citrus insect control is yet to be determined. Although, its use in the control of citrus thrips and scale insects is promising, much more work on a large scale is needed.--Boyce (95).

Taeniothrips inconsequens (Uzel), the pear thrips

A block of 12 trees in a Bartlett pear orchard was sprayed to control the thrips larvae. DDT in oil (2.5 quarts of 20 percent DDT in oil plus SH-20, an emulsifier, to 100 gallons of water) was as effective as rotenone or rotenone and oil in reducing the population. The DDT spray caused a spotted injury on the leaves.--Borden and Jeppson (93).

At Hood River, Ore., adult pear thrips on pear trees were controlled by a spray of 4 gallons of light medium oil containing 4 percent of DDT plus 2 gallons of Ortho ready-mix dormant oil per 100 gallons of spray applied in the bud scale drop stage. This mixture destroyed about 98 percent of the insects and remained effective for about 6 days. In another test this mixture was applied at $\frac{1}{3}$ the dosage at very early pink stage. The average population of thrips in the DDT plots was 38 for each 25 blossom clusters, whereas 1225 insects were found on 25 unsprayed blossom clusters. No injury from DDT was observed and the results indicate that a two-spray program would give highly effective control.--Childs and Robinson (111).

Gesapon No. 18, containing 5 percent of DDT in solution, was tested as a soil insecticide in 3 series of small plots. No thrips emerged

in a cage placed over a plot treated with 1 gallon of Gesapon No. 18 diluted 1 to 400 with water. The emergence in the control cage was 14 thrips.--Jones (231).

In Oregon one application of Gesarol A-20, 1 or 2 pounds plus 2 pounds of whale oil soap per 100 gallons of spray; also Gesarol SH-5 at the rate of 1 or 2 quarts per 100 gallons of spray; and also dusts containing 2 or 3 percent of DDT applied at the rate of 35 pounds per acre caused heavy mortality of adult thrips on prune trees. Gesapon 18 (5-percent DDT in oil) at the rate of from 1 to 4 quarts per 100 gallons of spray applied to the soil permitted 2 adults to emerge as compared to over 1000 from adjacent untreated plots.--Jones (232).

Taeniothrips simplex (Morison), the gladiolus thrips

Sprays containing 20 percent of DDT in pyrophyllite, with and without sugar, at the rate of 1 pound of DDT per 100 gallons, and a 3-percent DDT dust were applied to blooms of gladiolus. The spray treatments gave as good commercial control of thrips as recommended tartar emetic treatments. The dust was superior to the sprays in reducing injury to blooms when applied every second or third day.--N. J. Agr. Expt. Sta. (275).

Thrips nigropilosus Uzel, the chrysanthemum thrips

In greenhouse tests excellent control of chrysanthemum thrips was secured with 2 ounces of DDT in either powder suspension, acetone suspension, or Velsicol emulsion per 100 imperial gallons of water. Complete control was secured in a small-scale test with two applications of DDT, 4 ounces in Velsicol emulsion, and in a large-scale test with one application at 16 ounces. Observations showed that the eggs were not killed but newly hatching larvae were. Four ounces of DDT in acetone suspension gave excellent control of a fairly heavy infestation.--Ross (306).

Thrips tabaci Lind., the onion thrips

In small-plot tests for control of onion thrips on onions, the population was significantly reduced 24 hours after treatment with 2.5-, 5-and 10-percent DDT dusts applied at dosages ranging from 0.21 to 1.70 pounds of DDT per acre. Although the population decreased with the increase in quantity of DDT applied, there was no significant difference in the reduction obtained when 0.50 pound or more per acre was used. In small-plot tests conducted in 1943 one application of a 3-percent DDT dust gave very good kill of a heavy infestation of Thrips tabaci and Frankliniella fusca (Hinds) on cotton.--Loftin (247).

Small cotton plants lightly infested with onion thrips were treated with a 3-percent DDT dust (A-3) at the rate of 25 to 30 pounds per acre. After 24 hours no thrips could be found on these plants.--Smith (324).

See Autographa brassicae.--N. J. Agr. Expt. Sta. (275).

One application of Gesarol A-3 dust to cantaloup at the rate of 20 pounds per acre reduced the onion thrip 96.3 percent. On onions the reduction ranged from 65 to 87 percent.--Ewart (145).

Thrips on onions were controlled by eight applications of 5 percent DDT in light summer spray oil—average about ½ gallon per acre— made by hand atomizer from June 6 to August 1.--Gray (188).

At Twin Falls, Idaho, a 5-percent DDT dust, applied with a power duster to table onions at the rate of 25 pounds per acre gave 69 percent control of the onion thrips. In another experiment in which the material was applied with a hand duster the control was 63 percent. The DDT dust yielded greater control than a spray containing 4 pounds of 10-percent DDT per 100 gallons of water and applied with a traction sprayer under 350 pounds pressure at approximately 100 gallons per acre. This dust also gave greater control than a spray containing 1 quart of nicotine sulfate and 3 quarts of corn sirup per 100 gallons. On the other hand, in California a 10-percent DDT dust gave no better control than a spray containing 1 quart of nicotine sulfate, 4 pounds of sugar, and 8 ounces of a spreading agent per 100 gallons, and this nicotine spray was less effective than a DDT spray containing 6 pints of a 10-percent DDT emulsion per 100 gallons. In small-plot experiments at Beltsville, Md., the performance of DDT has conformed in general with the results of the field experiments in Idaho and California.--White (373).

Experiments testing DDT and other insecticides as sprays and dusts were conducted in the Salinas Valley, Calif. During 1944 in a comparison of spray treatments, a DDT emulsion was apparently superior to tartar emetic and sugar, nicotine sulfate and sugar, nicotine alkaloid, a dinitro-nicotine-kerosene mixture, and 3-percent DDT dust. Two applications of a DDT emulsion (1 pound of DDT to 100 gallons of water), at the rate of 190 gallons per acre, gave a 98.7 percent reduction in nymphs on July 27, one week after the first application; a 61.8 percent reduction 24 days after this spray treatment; and an 85.1 percent reduction 22 days after the second application (made on August 23). An analysis of onions from plots sprayed twice with the DDT spray mixture indicated that DDT was present on the tops and bulbs. When the onions (bulbs) were peeled, no DDT was found. Yield records obtained on October 23 from two plots sprayed twice with DDT emulsion gave increased yields of onions when compared with untreated check plots.--Lange and Thwaits (243).

Spray and dust applications with several insecticides were made to control the onion thrips in the San Joaquin Delta, Calif. DDT, applied as a spray or dust, was apparently more effective in reducing and preventing the increase of the onion thrips population than was a rotenone or dinitro spray. A 3-percent DDT dust at the rate of about 50 pounds

per acre checked the increase of thrips for a longer period than a 1 percent DDT dust, and the 1-percent dust prepared with methyl naphthalenes [Velsicol] was more persistent in its effects on the thrips population than the 1-percent dust prepared with acetone. In a field test better control of thrips was obtained with the DDT treatments than with nicotine sulfate. A DDT dosage of 2 pounds of 20 percent material with soap gave almost as good results as the 5-pound treatments. The increase in yield of the DDT-sprayed plots over the nicotine-sprayed plots was between 70 and 87 (100-pound) sacks of onions per acre. These figures adequately illustrate the value of keeping the thrips population under control.--Jeppson and Borden (228).

In the greenhouse a powder suspension containing 8 ounces of DDT per 100 imperial gallons of water gave excellent control (98 percent reduction over check) of thrips on potted onions. In the field one application failed to give more than a very temporary reduction in the population. Four days after spraying with formulations containing 16 ounces of DDT the average population per plant was 6.8 with the powder suspension, 16.0 with the Velsicol emulsion, and 77 in the check plots. However, within 9 days after treatment there was no appreciable difference between the treated and the untreated plots. Apparently few of the larvae at the base of the plant within the protection of the leaf sheath were killed. --Ross (306).

Preliminary laboratory tests with several concentrations of DDT dusts and sprays showed a definite possibility for controlling onion thrips, especially with the higher concentrations of DDT.--Granovsky (187).

A DDT aerosol produced excellent kills of thrips on onions.--Ditman (133).

Unidentified thrips

Under greenhouse conditions, 1 pound of DDT per 100 gallons of water, applied approximately every 2 weeks, controlled thrips and reduced spotted wilt of tomatoes more effectively than did frequent fumigation with nicotine. However, the treatment seriously damaged the plants, and it cannot be recommended unless further experiments show that such injury can be avoided. The composition of the spray was: 5 pounds of AK-20 containing 20 percent of DDT, 6 ounces of blood albumin, and 100 gallons of water.--Gardner et al. (164).

A 3-percent DDT dust was effective against thrips on chrysanthemums. --Haseman (203).

A fog made by feeding DDT in oil solution into a current of steam was effective in the Salt River Valley, Ariz., against thrips on grapefruit trees, beets,and cauliflower.--Anon. (49).

Large thrips populations that existed in all plots of alfalfa at the time of dusting were practically eliminated with DDT used in the form of a 10-percent dust in pyrophyllite.--Lieberman (245).

HEMIPTERA

(Suborder HOMOPTERA)

Aleyrodidae

Trialeurodes abutilonea (Haldeman)

One application of a 3-percent DDT dust (Gesarol A-3) on eggplant was made September 16 at a rate of 40 pounds per acre. One week later the number of nymphs on the underside of the basal leaves averaged 76.8 per leaf on the dusted plots and 38.8 on the undusted plots. It is believed the DDT reduced the number of predaceous insects, especially larvae of Chrysopis sp.--Ewart (145).

Trialeurodes sp., greenhouse whitefly

A 3-percent DDT dust was effective in the greenhouse.--Haseman (203)

There was some indication that 1.2 percent of DDT in oil applied as a vapo-spray was effective against whiteflies on peas.--Lange (241).

Aphiidae

Amuraphis roseus Baker, the rosy apple aphid

At Vincennes, Ind., early in April 1944, it was noted that trees sprayed with several formulations of DDT in 1943 had very low or no aphid populations, although adjacent trees were heavily infested. In 1944 DDT was slow in eliminating all three species of apple aphids already present, but they disappeared by midseason. The apple grain aphid and the rosy apple aphid disappeared earlier from the trees treated with DDT than they did from the untreated trees.--Baker and Porter (81).

DDT has shown promise in the control of apple aphids.--Steiner et al. (334).

Dormant miscible oil, containing DDT in solution, applied to give 5.12 ounces of DDT per 100 gallons, was inferior to a conventional ovicidal tar-petroleum miscible oil in killing the eggs of the rosy apple aphid, but did reduce early bud infestation markedly as compared with untreated checks. DDT in oil permitted multiplication of the spring and early summer population of the aphids much more than the tar-petroleum spray.--Cleveland (114).

Aphis gossypii Glov., the cotton aphid, the melon aphid

DDT was not effective and seemed to cause about the same increase in aphids as did calcium arsenate, under the conditions of light aphid infestations that prevailed in 1944. In field experiments at Tallulah, La., and at Waco and Bryan, Tex. the aphid populations in plots dusted 3 to 6 times with DDT were about equal to those in the plots similarly dusted with calcium arsenate. The addition of 2.5 percent of DDT to the calcium arsenate used in an experiment at Tallulah caused a greater increase in aphids than undiluted calcium arsenate or 5 percent of DDT in pyrophyllite, but when 1 percent of nicotine was added to the DDT-calcium arsenate the aphids were held in check. In a large-scale experiment at Waco the adults and larvae of the lady beetle were reduced 67 percent in the DDT plot and 70 percent in the calcium arsenate plot. At Tallulah these predators were reduced 75 percent in field plots dusted with 5 percent DDT and 83 percent in the calcium arsenate plot. --Loftin (247).

The average number of aphids per 10 feet of rows on muskmelon plants dusted with 6 percent of Lethane, 5 percent of Thanite, 3 percent of nicotine sulfate, and 3 percent of DDT, was 329, 639, 586, and 803, as compared with 2,048 for the control treatment.--Wolfenbarger et al. (379).

A 3-percent DDT dust and a spray containing 1 pound of actual DDT in 100 gallons of water were inferior to a nicotine-soap spray 1-800 against melon aphid.--N. J. Agr. Expt. Sta. (275).

In greenhouse tests 1, 2, and 4 ounces of DDT in Velsicol emulsion per 100 imperial gallons of water gave aphid kills of 80.8 percent, 95.6 percent, and 98.4 percent, whereas in powder suspension 4, 8, and 16 ounces of DDT per 100 imperial gallons of water killed 69.9 percent, 76.6 percent, and 80.3 percent.--Ross (306).

Eighty hills of cantaloups received two early treatments of cryolite and five applications of either 3-percent DDT dust or 20 percent (Gesarol) spray. An infestation of melon lice developed on these plots and spread to the plots treated with cryolite.--Gould (184).

Small, lightly infested cotton plants were dusted with a 3-percent DDT dust (A-3) at the rate of 25 to 30 pounds per acre. There was no apparent control.--Smith (324).

In the experimental applications of DDT to cotton, aphids increased. DDT is the most effective material yet found against the pink bollworm but it causes an increase of aphids.--Annand (74).

Three applications of Gesarol A-3 dust to cantaloup at the rate of 30 pounds per acre were ineffective against aphids.--Ewart (145).

Pyrophyllite dusts containing 5 percent of DDT or 5 percent of DDT plus 5 percent of yellow copper oxide completely failed to control the melon aphid in commercial plantings of melons.--Granovsky (187).

Aphis pomi Deg., the apple aphid

Gesarol AK-20 spray, 2 pounds with 6 2/3 pounds of wettable sulfur per 100 gallons of water, appeared to prevent heavy buildup of aphid populations on Red Delicious apples in New Hampshire during the 1944 season. Five applications were no better than three, and the Gesarol acted slowly.--Conklin (116).

See Empoasca maligna .--Granovsky (187).

Aphis spiraecola Patch, the spirea aphid

Gesarol A-3 Dust (3 percent DDT) was applied to Vanhoutte spirea fairly heavily infested with aphids, and after 5 days there was little apparent control. One application of a nicotine dust eliminated the infestation within a few hours.--Ross (306).

Cylindrical wire cages were placed over sprigs of spirea infested with aphids and placed in bottles of water. The insides of the cages, the foliage, and the paper toweling on which the cages rested were sprayed with Gesarol A-20, 0.8 pound in 100 gallons of water. The aphids were apparently uninjured by the DDT.--Fluke and Pond (157).

Brevicoryne brassicae (L.), the cabbage aphid

A higher population occurred in the plots treated with a dust containing 3 percent of DDT or with a spray of 2 pounds of Gesarol AK-20 per 100 gallons of water. At the time of harvest, parasites and predators appeared prevalent in all the plots, and it may be that aphid abundance in the DDT plots was due in part to possible migration of aphids caused by the more succulent and vigorous growing DDT-treated plants.--Allen and Brunn (71).

See Trichoplusia ni.--N. J. Agr. Expt. Sta. (275).

Late cabbage and broccoli were treated with a 3-percent DDT dust and a 20-percent DDT spray. Lice colonies were present on four plants in the DDT-treated plots, and on 2 in the dust-treated plots; there were none on the check.--Gould (184).

Chromaphis juglandicola (Kltb.), the walnut aphid

DDT was observed to kill the walnut aphid when it was being used against the codling moth on walnuts at Linden, Calif. It also killed the predators and probably the parasites. Eventually, however,

serious infestations of the pest developed. Apparently DDT remains effective against the predators and parasites longer than against the aphid itself. Thus the aphid becomes established and builds up a large population before being subjected to its natural enemies. The results of this investigation indicate that more work is needed before any recommendations can be made for the use of DDT as an insecticide on walnuts.--Michelbacher et al. (260).

Eriosoma lanigerum (Hausm.), the woolly apple aphid

In the fall of 1944 at Vincennes, Ind., aerial colonies of this species were common on trees treated with lead arsenate, but absent from trees treated with DDT or nicotine. At Yakima, Wash., it was noted that woolly aphids had become much more common in some apple trees sprayed with DDT (1 part plus 2 parts of pyrophyllite) than in adjacent trees sprayed with lead arsenate. Tests made on this species in October with DDT resulted in almost no control whatever. It was only by dissolving the DDT in a petroleum oil derivative, and using an emulsion of this solution with a wetting agent, that anything approaching satisfactory control of this aphid was obtained.--Baker and Porter (81).

When DDT was used on a block of apple trees it gave sensationally good control of the apple worms but killed off the small parasitic wasps introduced 10 years ago to check the woolly aphid. As soon as these aphids are freed of their natural enemies they increase immediately to dangerous numbers.--Burtner (98).

DDT failed to kill the woolly apple aphids, whereas it practically eliminated all the beneficial insects that act as predators or parasites of this plant louse, including at least two species of syrphid flies, lace wings, lady beetles and the very important internal parasite Aphelinus mali Hald. which, after its introduction into the Hood River area in 1928, so reduced the aphid population that this pest has been of minor importance since that time. In the mid-Columbia apple-growing districts, a biological upset of this character is of major importance, since the woolly apple aphid is associated with the spread of a serious canker disease known as perennial canker, Gleosporium perennans, which attacks both trees and fruit. Following the introduction of Aphelinus mali and its establishment throughout the district, aphid populations were so reduced that canker likewise became of minor importance. Any spray practice that would tend to build up the aphid population would likewise lead to a serious increase of canker disease with disastrous results.--Childs and Robinson (111).

Macrosiphoniella sanborni (Gill.), the black chrysanthemum aphid

DDT at 1 ounce per 100 imperial gallons of water gave 100 percent control. The DDT was emulsified by adding to water a solution of 20 grams

of DDT in 10 ml. of Triton X-100 and sufficient Velsicol AR60 to make 100 ml.--Ross (306).

Macrosiphum pisi (Kltb.), the pea aphid

Under greenhouse conditions at Madison, Wis., a 10 percent DDT-pyrophyllite mixture killed all aphids after 1 day; a 5-percent mixture after 2 days; and a 1-percent mixture after 3 days. The mortalities were much higher at 63°-65°F. than at 51°-55°. In tests conducted on the residual effect of DDT when dusted on pea plants, the residues of the 5-percent and 10-percent dusts applied 1, 3, 5, 11, 14, and 21 days before exposure to aphids gave 84 percent mortality of the aphids in 1 day and 100 percent mortality in 3 days. In other tests the 1 percent and 0.5 percent strengths of DDT had greater residual effect than did mixtures containing 0.5 percent of rotenone. At Columbus, Ohio, the aphids were tested by use of a bell-jar duster. DDT was very effective and appeared to be more so than derris at comparable strengths. A 0.625-percent mixture killed all the aphids 3 days after dusting.--Dudley et al. (139).

Both 5- and 10-percent DDT aerosols applied at 10 pounds of solution per acre (1½ pound of actual DDT) gave 85 to 99 percent reduction of pea aphid populations as compared with untreated plots. Ten pounds of aerosol solution containing 5 percent each of DDT, cyclohexanone, and lubricating oil, 35 percent of acetone, and 50 percent of methyl chloride per acre has given excellent control of the pea aphid.--Ditman (133).

A dust containing 3 percent of DDT gave control as good as the commonly used rotenone-lethane or rotenone-nicotine dusts. However, none of these gave entirely satisfactory results and in one instance where the results were especially poor, the grower retreated the whole field with vaporized nicotine.--Walker (365, 366).

During August and September in California several mixtures containing oil and DDT were applied to peas as vapo-sprays. From the standpoint of pea aphid control, DDT appears to be fairly effective in oil when applied by the vapo-spray machine; the kill is in direct proportion to the amount of DDT present. Combinations of 1.2 percent DDT and 0.05 or 0.25 percent rotenone were superior to 1.2 percent DDT alone, and about the same as 2.4 percent DDT.--Lange (241).

Tests were made on acre plots of Alaska peas. A spray of 1 pound of DDT and ½ pound of Vatsol OS in 100 gallons of water was compared with a spray containing 3 pounds of cube powder (5 percent rotenone) and ½ pound of Vatsol OS. Sprays were applied at the rate of 180 gallons to the acre at 325 pounds' pressure. A 3-percent DDT dust was compared with a 0.75-percent rotenone dust, a 2 percent free nicotine-0.5 percent

rotenone dust, and a 0.25 percent rotenone-1 percent DDT dust on duplicate half-acre plots. Applications were made with a motorized duster, with a 25-foot dusting curtain, at the rate of 45-50 pounds per acre. In sprayed plots initial control was about equal between the rotenone and DDT sprays but after a week the population on the DDT plot began to build up rapidly while the population on the rotenone plots remained low. The 3-percent DDT dust was the poorest treatment and the rotenone-DDT dust next to the poorest. The other dusts gave excellent control. The DDT-sprayed plots gave 90 percent and the DDT-dusted plots 70 percent of normal yield based on the rotenone plots.--N. J. Agr. Expt. Sta. (275).

In laboratory tests in 1943 DDT showed a toxicity to the pea aphid comparable to that obtained with rotenone dust mixtures. Results of field experiments at Madison, Wis., did not substantiate these consistent laboratory results. For example, in one experiment the application of 5-percent DDT dust with a power duster at the rate of 35 pounds per acre, followed by heavy rains, resulted in 99 percent control after 7 days as compared with 88 percent for a 0.5-percent rotenone dust containing 2 percent of a light mineral oil. In this experiment the average yields of shelled peas per acre in five quarter-acre plots were 1,517, 859, and 495 pounds, for the DDT, the rotenone, and the check treatments. In a second experiment, also followed by rains, a 5-percent DDT dust gave less outstanding results than those obtained with several dosages and strengths of rotenone dust mixtures. In a third experiment, under wet conditions but accompanied by very little precipitation, both the 5- and 10-percent strengths of DDT were less effective than a dust containing 0.75 percent of rotenone and 2 percent of a light mineral oil. --White (373).

Field experiments in 1944 indicated that DDT was highly toxic to the pea aphid, but for best results the amount would need to be increased from 3 percent to 4 or 5 percent.--Wilson (376).

Careful examination of the ground under hairy vetch at Oregon City, Oreg., disclosed that 5-percent DDT dust had killed insects of several species. Pea aphids were present in large numbers on some of the plots, but only a few appeared to have been killed by DDT.--Rockwood and Reeher (303).

Macrosiphum solanifolii (Ashm.), the potato aphid

In field experiments tomato plants (7 replications) were sprayed five times with tribasic copper sulfate, flour, DDT (4-2-1-100) or calcium arsenate, lime (4-8-100). The applications were made with a knapsack sprayer at 10-day intervals starting July 13. Both treatments were about equal against the potato aphid. The general appearance and vigor of the DDT-treated plots was definitely inferior to that of the

calcium arsenate-treated plots. The DDT plots yielded 19 tons per acre whereas the calcium arsenate plots yielded 22 tons.--N. J. Agr. Expt. Sta. (275).

See Heliothis armigera.--Wolfenbarger et al. (379).

Myzus persicae (Sulz.), the green peach aphid

In western Nebraska potato fields the aphid populations on DDT-treated plots remained at a level equal to or lower than that of the check plots. In contrast, the increases on plants treated with zinc arsenite were highly significant. In repeated tests under greenhouse conditions, heavy populations of Myzus persicae were eradicated within 48 hours with a 3-percent DDT dust. This species was unable to reestablish itself on such plants for some time afterwards.--Tate et al. (342).

Aphid populations on potato plants in plots treated with DDT dust or spray remained at a very low level in contrast to marked increases on plants sprayed with zinc arsenite.--Hill (209).

Rhopalosiphum prunifoliae (Fitch), the apple-grain aphid

Same as for Amuraphis roseus.--Baker and Porter (81).

Rhopalosiphum pseudobrassicae (Davis), the turnip aphid

See Trichoplusia ni.--N. J. Agr. Expt. Sta. (275).

Rhopalosiphum rufomaculatum Wilson, the green chrysanthemum aphid

Acetone suspensions and Velsicol emulsions of DDT at 2 to 4 ounces of DDT per 100 imperial gallons of water gave 100 percent mortality, but powder suspensions killed only two-thirds of the aphids at 8 ounces of DDT per 100 imperial gallons.--Ross (306).

Sipha flava (Forbes), the yellow sugarcane aphid

The aphid infestation was noticeably greater in DDT-treated plots than in plots receiving any other treatments or untreated.--Ingram et al. (222); also Packard (285).

Unidentified aphids

A DDT-oil fog used to control grape leafhoppers in Arizona did not kill aphids.--Vorhies and Wehrle (364).

In an orchard in Buena Park, Calif., citrus aphids became serious pests after DDT was used, whereas they were of no commercial importance in plots where oil only was used.--Ebeling (142).

Aphids on cole crops and beans were not controlled by eight applications of 5 percent DDT in light summer spray oil--average about 1/2 gallon per acre--made by hand atomizer from June 6 to August 1.--Gray (188).

One percent of DDT in kaolin was dusted on sheets of paper on which insects were separately placed and covered with a beaker. This dust proved ineffective against aphids.--Sen (311).

Large aphid populations that existed in all alfalfa plots dusted with 10 percent of DDT in pyrophyllite were practically eliminated. Most of the common alfalfa-field insects observed in the DDT-treated plots probably were immigrants.--Lieberman (245).

Cercopidae

Aphrophora saratogensis (Fitch), the Saratoga spittle bug

At Milwaukee, Wis., oil emulsions containing from 0.1 to 1 percent of DDT were tested. Sprayed pine trees showed no sign of tip kill at the end of the season. The material appeared to have a distinct repellent effect, but when the insects were caged on sprayed branches complete mortality usually resulted in 24 hours.--Craighead and Brown (125).

Unidentified spittle bugs

A DDT aerosol produced excellent kills of spittle bugs on peas.--Ditman (133).

Philaenus leucophthalmus (L.), froghopper

Greenhouse and insectary tests: DDT, 4 ounces in powder suspension per 100 imperial gallons of water, applied as a residual poison on foliage gave complete control of froghoppers. The same spray applied only to insects killed 98 percent; at 8 ounces 100 percent were killed. When used in a Velsicol emulsion 1 ounce of DDT per 100 imperial gallons of water killed 88 percent of the insects and 4 ounces killed 94 percent. Gesarol A-3 dust applied to spittle had no apparent effect on nymphs.--Ross (306).

Cicadellidae

Aceratagallia uhleri (Van D.), the western clover leafhopper

In Nebraska 3-percent DDT dust reduced the population to an insignificant level.--Tate et al. (342).

A 3-percent DDT dust and a spray containing 4 pounds of 10-percent DDT in pyrophyllite per 100 gallons of water greatly reduced the numbers of adults and nymphs on potato plants in western Nebraska.--Hill (209).

Dikraneura cockerellii Gillette

Same as for Erythroneura variabilis. --Anon. (49), Vorhies and Wehrle (364)

Empoasca abrupta DeL., the western potato leafhopper

In small field tests a 3-percent DDT dust, or a 1-percent DDT dust with sulfur, reduced the leafhopper-nymph population about 95 percent for at least 19 days. Dusting sulfur alone reduced the number of nymphs by about 50 percent.--Jeppson and Borden (229).

Empoasca fabae (Harr.), the potato leafhopper

The potato leafhopper is controlled best by the higher (5 percent) concentration of DDT dust. The residues conspicuously gave more satisfactory kill of the young nymphs than the adult leafhoppers.--Granovsky (187).

At Beltsville, Md.,a great reduction in numbers of the potato leafhopper on alfalfa and peanuts was obtained by two applications 9 days apart of a dust containing 2 percent of DDT in pyrophyllite, or of a spray consisting of a mixture of 0.66 percent of DDT in dust form with water, with a spreader added. Material increase in yield and quality of hay was obtained in the treated alfalfa plots. Two applications 16 days apart of the same spray and dust to peanuts resulted in great reduction of the leafhopper population but no increase in yield because of severe leaf spot infection on both treated and untreated plots late in the season.--Packard (285).

Although the knock-down of leafhoppers right after treatment with DDT is less conspicuous than with pyrethrum, DDT gave better long-run results and almost complete control of the leafhopper nymphs for a long time after each application.--Granovsky (185).

Potato leafhoppers were kept down by three applications of a 5-percent DDT dust per season.--Granovsky (186).

A wettable powder containing 25 percent of DDT (4 pounds per 100 gallons of water), applied at the rate of 125 gallons per acre, was more effective in controlling insects and increasing yield than Bordeaux 8-12-100. The addition of 4 pounds of Fermate or Grasselli CAC still further enhanced the yield.--Gui (192).

Significant reductions on potatoes in Nebraska were obtained with a 3-percent DDT dust and a 10-percent DDT spray, 4 pounds per 100 gallons of water. In another experiment replicated plots of potatoes which were heavily infested with potato leafhoppers were treated three times with a 1 percent DDT dust at approximately 2-week intervals. Within 12 hours after the first treatment leafhopper populations were reduced to a relatively insignificant level and this condition was maintained for 2 weeks even in the presence of frequent heavy rains. Foliage on the treated plants remained green and the plants matured at the normal time, whereas foliage on the untreated plants was almost all dead 2 weeks earlier. An increase in yield of approximately 265 percent was obtained. Field plots of beans heavily infested with potato leafhoppers were treated on June 19 with 1 or 3 percent DDT dusts. Nymphal population records were taken four times during the next 17 days. After 12 hours leafhopper nymphs were reduced to a very low and apparently insignificant level by both the 1 percent and 3 percent dusts. Although the difference between the two dusts was not statistically significant, apparently the 3 percent dust was slightly better.--Tate et al. (342).

In small-plot experiments, 3-percent DDT dust gave good control of the nymphs and yielded 115 bushels of potatoes per acre, while 4-4-50 bordeaux plus 2 pounds of calcium arsenate yielded 98 bushels.--Apple (75).

In a field test on beans 8 ounces of DDT per 100 imperial gallons of water gave complete control as a powder suspension and in Velsicol emulsion. Apparently newly hatched nymphs were killed as well as the older nymphs and adults.--Ross (306).

At Jefferson, N. C., plots treated with a 3-percent DDT dust for the control of flea beetles and leafhoppers yielded more potatoes than did any of five other differently treated plots.--Kulash (240).

Laboratory tests with a 3-percent DDT dust gave 96 percent control in 3 hours.--Okla. Agr. Expt. Sta. (278).

A 5-percent DDT dust gave excellent control of the potato leafhopper on potatoes.--Hutson (220).

DDT furnishes one of the best examples of the need of proper spacing between plots when spraying or dusting and the influence of drifting materials on adjacent plots. The drift of small amounts of DDT into plots during applications and the carry-over of the same material on the

inside walls of spray equipment to contaminate the next-used formula, are sufficient to reduce materially leafhopper populations and, thus, to increase the yields of sprayed potatoes. The drift effect was distinguishable for a distance of about 8 feet on each side of rows treated with DDT.--Wilson and Sleesman (377).

In a planting of early potatoes where the potato leafhopper became very abundant, four chemical treatments—DDT spray (Gesarol A-20) 4 pounds per 100 gallons of water (0.8 pounds of actual DDT); DDT dust (Gesarol A-3) 3 percent; calcium arsenate 4 pounds, with fixed copper (Compound A) 3 pounds per 100 gallons of water; and bordeaux mixture 5-4-50—gave results as follows: Leafhoppers per 16 leaves, 4, 5, 17, and 19; European corn borers per 10 potato stalks, 0, 2, 11, and 24; yields, bushels per acre, 179, 167, 146, and 116. The averages on the controls were 81 leafhoppers, 23 European corn borers, and 110 bushels per acre yield.--Wolfenbarger et al. (379).

Materials tested were 4-percent DDT dust containing 21 percent of Microgel with a 30-70 copper-lime dust, and a Microgel-calcium arsenate-talc (21-30-49) dust. Four applications were made during the growing season at the rate of 30 pounds per acre-application (4 replications). Yield of potatoes was 257 bushels on the DDT-Microgel plot as compared with 231 on the Microgel-calcium arsenate-talc plot. Excellent control of this leafhopper was obtained. The control of potato flea beetles and Colorado potato beetle with the DDT dust was about equal to that of the calcium arsenate dust.--N. J. Agr. Expt. Sta. (275).

A wettable powder containing 25 percent DDT, 4 pounds per 100 gallons of water, applied at the rate of 200 gallons per acre at 10-day intervals killed all nymphs and increased the yield of potatoes more than any other treatment.--Sleesman (321).

In experiments conducted in southern Wisconsin a 2.5-percent DDT dust reduced infestations of the potato leafhopper on potatoes and beans 78 to 99 percent. These figures were obtained from counts of leafhopper nymphs 1 to 3 weeks after application. The DDT dust gave a greater reduction in leafhopper populations than did a dust mixture containing 1 percent of dinitro-o-cyclohexylphenol and 50 percent of sulfur.

In similar experiments in the Columbus, Ohio, area DDT sprays and DDT-sulfur dusts gave better results than did the dinitro mixture or a pyrethrum-sulfur mixture containing 0.025 percent of pyrethrins and 50 percent of sulfur. The DDT sprays contained up to 0.08 percent of DDT in a kerosene emulsion, and the dust mixtures consisted of 1.4 percent of DDT, 50 percent of sulfur, and the remainder pyrophyllite.--White (373).

A knapsack sprayer was used in making five applications of 20 percent DDT spray on early potatoes and three applications on late potatoes. Potato leafhopper counts with the different treatments varied considerably, but the population was definitely lower on the DDT plots than on the check.--Gould (184).

In the laboratory Gesarol A-3 dust killed 96 percent of the adult leafhoppers at the end of 3 hours.--Hamilton (200).

DDT at 0.75 pound per 100 gallons of water was not effective as a fungicide for early blight of potatoes, but controlled leafhoppers well. --Heuberger (207).

A 3-percent DDT dust and a spray containing 1 pound of DDT in 100 gallons of water were tested against standard treatments. The DDT spray and the dust gave control of potato leafhopper on snap and lima beans superior to that obtained with pyrethrum dust. Snap beans were stunted for a short period after they were treated with DDT.--N. J. Agr. Expt. Sta. (275).

A dust containing 5 percent of DDT and copper applied twice at the rate of 20 pounds per acre per application gave the highest mortality of insects, including the potato leafhopper, of any material tested (arsenical, Dithane, DN dust plus copper, sabadilla plus copper, and copper-lime dust).--Munro and Redman (270).

Empoasca maligna (Walsh), the apple leafhopper

Apple nursery stock was dusted with a 5-percent DDT dust twice during the season at 1-month intervals. The effectiveness of this treatment was compared with that of 4-4-50 bordeaux mixture applied 6 times between June 21 and August 12, 1944. The last three bordeaux sprays were mixed with 3/4 pint of nicotine sulfate per 100 gallons. Both treatments controlled the leafhoppers about equally well. Nicotine sulfate took fairly good care of Aphis pomi Deg. in the bordeaux block and the aphid population in the DDT block did not increase. This shows that some of them were controlled with the DDT. Since the average annual growth in the DDT block measured 17.23 inches, in the bordeaux block 15.55 inches, and in the control block 16.05 inches, it is evident that frequent bordeaux application reduces, whereas dusting with DDT slightly increases the annual growth of young apple nursery stock.--Granovsky (187).

Apple leafhoppers were controlled with a spray of 4 pounds of 20 percent DDT per 100 gallons of water.--Haseman (203).

DDT is very effective against apple leafhoppers.--Steiner et al. (334).

DDT at 1 or 2 pounds per 100 gallons of water eliminated this species and also the rose leafhopper (Typhlocyba rosae (L.), both of which were rather abundant in an apple orchard in Hood River, Oreg.--Childs and Robinson (111).

Erythroneura comes (Say), a grape leafhopper

DDT-pyrophyllite (20-80) was used at the rate of 1 pound of DDT in 100 gallons of water plus 1/2 pound of soybean flour. The spray was compared with a lead arsenate-bordeaux mixture. Applications were made at the rate of 200 gallons per acre on July 15 and 27. The entire vineyard was treated with the DDT spray on August 9. Most of the spray was directed toward the upper surface of the leaves to avoid spraying the fruit. In the plot receiving three DDT sprays the infestation disappeared after the second application. In the plot receiving one spray of DDT following two lead arsenate-bordeaux sprays, the leafhopper infestation was under control for about 10 days. There was no injury from DDT sprays to foliage.--N. J. Agr. Expt. Sta. (275).

The grape leafhopper was controlled by 3 sprayings with 1 pound of DDT per 100 gallons of water.--Hutson (220).

Erythroneura elegantula Osb., a grape leafhopper

DDT was tested against this important pest of grapes in the San Joaquin Valley, Calif. In these trials, DDT applied either as a vapo-spray or as a dry dust mixed with sulfur appeared to be effective against adults and nymphs of the grape leafhopper. Toxicity to nymphs persisted at least 22 days. The effect of treatment was noticed 4 months after application. The vapo-sprays contained 0.6 or 1.2 percent of DDT in a mixture of 10 percent light summer oil (60 viscosity) and 90 percent of kerosene. The dusts contained 50 percent of sulfur, sufficient A-K 20 to make 1, 3, or 5 percent DDT, and the remainder Frianite.--Frazier and Stafford (159).

Erythroneura variabilis Beamer

A 5 percent DDT-oil fog made by feeding a DDT-oil solution into a current of steam proved effective in the Salt River Valley, Ariz. First trial was on a 10-acre block of Bumstead grapes where leafhoppers averaged 70 to the vine. A pick-up truck, carrying a generator, ran along two sides of the block for 7 minutes. In that time 14 gallons of orchard spray oil containing 5 percent of DDT was turned into a fog that was carried over into the vines by a light breeze. The population 1½ days later was 1 leafhopper per vine. In the next few days 100 acres were "fogged," with the same result. The leafhoppers were wiped out.--Anon.(49), Vorhies and Wehrle (364).

Erythroneura spp., grape leafhoppers

A spray of 1 pound of DDT per 100 gallons of water used against Popillia japonica Newm. gave excellent control of leafhoppers on grapes.--Hadley and Fleming (196).

A 3-percent DDT dust was effective against leafhoppers on grape.--Haseman (203).

Promising results in the control of the grape leafhopper were obtained in preliminary tests in Ohio with 1.5 pounds of DDT (dissolved in a mixture of benzene and kerosene which was then emulsified) per 100 gallons, and in New Jersey with the same formula as used in tests against adults of the Japanese beetle.--Baker and Porter (81).

One application of DDT, 8 ounces per 100 imperial gallons of water, on July 15 gave complete control of nymphs and prevented breeding for the remainder of the season. In a large-scale field test two applications of DDT, 16 ounces, at 10-day intervals, gave apparently 100 percent control.--Ross (306).

Eutettix tenellus (Bak.), the beet leafhopper

In 11 replications of a field experiment with the beet leafhopper on sugar beets at Twin Falls, Idaho, 115 pounds per acre of a 5-percent DDT dust resulted in an average reduction in populations of 95 percent after 3 days and 89 percent after 10 days. A spray containing 4 pounds of 10-percent DDT applied at 200 gallons per acre did not give so great a reduction.--White (373).

Macrosteles divisus (Uhl.), the six-spotted leafhopper

A large carrot field was divided into plots with an area of 1.335 acres for each of six treatments, two of which contained DDT at 20 and 25 pounds per acre in three applications per season. DDT, 5 percent in pyrophyllite, and also 5 percent plus 5 percent of yellow copper oxide in pyrophyllite, gave very satisfactory results in controlling this insect, and a greater percentage of disease-free carrots as compared with other plots.--Granovsky (185, 186, 187).

A 3-percent DDT dust was compared with a 1 percent rotenone-25 percent sulfur dust and an untreated check. Dusts were applied to a commercial planting of Big Boston lettuce with a self-propelled 6-row power duster using two nozzles per row. Five applications were made at weekly intervals, the first one when the leaves were about 1 inch in diameter. The dusts were applied at the rate of 25-30 pounds per acre. A rotenone-sulfur dust was substituted for the DDT at the fifth application. Leafhopper counts 3 days after the third application were as follows: DDT 0.20

per plant; rotenone 0.09 per plant, check 3.36 per plant. Lettuce yellows counts at harvest were: DDT 8.3 percent, rotenone 4.4 percent, check 31.8 percent.--N. J. Agr. Expt. Sta. (275).

Typhlocyba pomaria McAtee, the white apple leafhopper

The results of preliminary experiments indicate that DDT may effectively control some species of leafhoppers. At Yakima, Wash. and at Vincennes, Ind., the DDT formulas used for control of the codling moth (1 pound DDT per 100 gallons of water) also appeared to control apple leafhoppers (chiefly Typhlocyba spp.).--Baker and Porter (81).

Injury was practically absent from codling moth plots receiving DDT, but noticeable on adjacent lead arsenate-oil plots.--Ross (306).

Typhlocyba rosae (L.), the rose leafhopper

See Empoasca maligna.--Childs and Robinson (111).

Unidentified leafhoppers

One application of a DDT aerosol caused 100 percent reduction of aster leafhoppers on lettuce.--Ditman (133).

The bean leafhopper was completely eliminated with one application of DDT. [Presumably a 3-percent dust] Apparently the DDT did not act as an ovicide.--Russell (308).

Coccidae

Aonidiella aurantii (Mask.), the California red scale

The addition of 4 grams of DDT to 100 ml. of light medium spray oil increases the effectiveness of the oil, based on counts made to ascertain the degree of infestation on trees 3 to 14 months after treatment. Only 2 out of 5 treatments applied during November, 1943, produced a marked improvement in red scale control due to the addition of the DDT. However, in experiments made during the spring and summer months the DDT always increased the effectiveness of the oil. Three percent kerosene containing 4 percent of DDT was never so effective as the 1 3/4 percent light medium or heavy medium spray oil with which it was compared, but increasing the amount of DDT in the kerosene by means of solvents or spraying twice a year with the 3 percent kerosene-DDT solution gave promising results and will warrant further investigation, especially since kerosene does not accentuate water spot of navel oranges as does regular oil spray.

Gesarol AK-20, a proprietary powder containing 20 percent of DDT, was used as a spray (without any oil) at 10 pounds to 100 gallons of water, but even in double applications it was not so effective as 1 3/4 percent light-medium or heavy-medium oil spray. A 5-percent DDT dust, using 1½ pounds per tree in two applications, one in July and one in August, resulted in no improved red scale control when compared with the untreated check plot. In the past year's field work, cube root added to kerosene-DDT spray decreased the longterm effectiveness of the spray 5 times in the 6 trials in which the comparison was made. This is a highly paradoxical situation since cube root increases many-fold the ability of kerosene to kill red scale. It cannot be argued in this instance that the insecticidal effect of the cube root against the relatively unimportant predators and parasites of the red scale outweighed its effect in increasing the initial kill of the red scale, for the DDT appears to be even more effective against predators and parasites and this material was present in all the kerosene sprays.--Ebeling (142).

The addition of DDT to oil sprays produced little or no immediate effect, but the residual value against the crawlers was considerable in cool weather as compared with that in hot weather.--Baker and Porter (81).

The value of DDT for citrus insect control is yet to be determined. Although the material is promising for the control of citrus thrips and scale insects much more work on a large scale is needed.--Boyce (95).

Aspidiotus perniciosus Comst., the San Jose scale

A spray of 4 pounds of 20-percent DDT per 100 gallons of water applied to apple trees did not control this scale on the fruit.--Haseman (203).

Chrysomphalus aonidum (L.), the Florida red scale

No benefit appeared to result from the addition of DDT to oil sprays. --Baker and Porter (81).

Chrysomphalus dictyospermi (Morg.), the dictyospermum scale

An emulsion containing about 0.2 percent of DDT, applied four times within 5 months, proved highly effective against these scales on about 30 species of orchids. The emulsion was prepared by adding a solution of 20 parts by weight of DDT in 60 parts of xylene and 20 parts of Triton X-100 to water. Young scales or crawlers are unable to live on any portion of the plant that has been coated with the spray. All mature scales will not be killed by a single application but repetitions of the sprays at 3- or 4-week intervals should ultimately eliminate all scales, both young and old. No injury to the plants occurred.--Cory (119).

Coccus hesperidum L., the soft scale

Coccus pseudohesperidum (Ckll.)

Diaspis boisduvalii Sign.

Same as for Chrysomphalus dictyospermi (Morg.).--Cory (119).

Lepidosaphes ficifoliae (Berlese), a fig scale

Field tests with DDT residual spray to control crawlers were unsuccessful in all but one doubtful case where a talc powder containing 20 percent of DDT was applied at 4 pounds per 100 gallons of water plus 1/4 percent heavy-medium soluble oil on July 17. It is not known what control a 1-percent heavy-medium oil spray would give if it were applied along in July.--Stafford (327).

Lepidosaphes ficus (Sign.), the fig scale

Same as for Chrysomphalus aonidum.--Baker and Porter (81).

Lepidosaphes tuberculatus (Sign.)

Same as for Chrysomphalus dictyospermi (Morg.).--Cory (119).

Lepidosaphes ulmi (L.), the oystershell scale

DDT is not effective against the adult scales, but is effective against the crawlers or migrating young.--Annand (74).

Parlatoria chinensis Marlatt

The addition of DDT to oil sprays improved the immediate kill but had no residual effect on the crawlers.--Baker and Porter (81).

Parlatoria oleae (Colvée), the olive scale

Tests were conducted in the laboratory and in the field with a hand sprayer and a power-driven sprayer using a 20 percent DDT wettable powder and DDT dissolved in oils. In none of the tests conducted were the results satisfactory for commercial practice. Control of olive scale always increased with viscosity and concentration of oil regardless of concentration of DDT. Even fresh deposits of DDT did not prevent many crawlers from settling and reaching the second instar. The use of DDT seems, therefore, to offer no solution to the problem of controlling olive scales that settle under their mothers' shells.--Stafford (327).

Parlatoria proteus Curt.

Same as for Chrysomphalus dictyospermi (Morg.).--Cory (119).

Pseudococcus citri (Risso), the citrus mealybug

In one small-scale test in a greenhouse there was no appreciable kill from one application of a spray containing 24 ounces of DDT in powder form per 100 imperial gallons of water.--Ross (306).

Pseudococcus comstocki (Kuw.), the Comstock mealybug

In laboratory and orchard tests DDT at the rate of 1.5 pounds per 100 gallons has been found promising for control of this mealybug. Laboratory tests indicate that the spray affects the young mealybugs but not the mature females. The spray deposit is considerably more toxic after a few hours than after 12 to 13 days.--Hough (217).

Results obtained with DDT on the newly hatched crawlers were promising enough to warrant further tests.--Baker and Porter (81).

Pseudococcus maritimus (Ehrh.), the grape mealybug

Results with DDT on plants were unsatisfactory. Three weeks after spraying 70 percent of the plants showed infestation by Pseudococcus maritimus, whereas plots sprayed with Loro were only 11 percent infested. The DDT formula consisted of 10 pounds of 10 percent DDT in pyrophyllite (1 pound of DDT) in 100 gallons, with 3 fluid ounces of Du Pont spreader-sticker added. Applications were made with a power sprayer, 500- to 600-pounds pressure, with two large disc nozzles.--Houser and Neiswander (219).

Pseudoparlatoria perlatorioides (Comst.)

Saissetia hemisphaerica (Targ.), the hemispherical scale

Same as for Chrysomphalus dictyospermi (Morg.).--Cory (119).

Saissetia oleae (Bern.), the black scale

Two field tests were made against this pest on olives. An oil-DDT spray (2 gallons of a light medium soluble oil containing 5 percent of DDT per 100 gallons of water) and an oil-derris spray (0.5 pound of derris containing 5 percent of rotenone per gallon of heavy medium oil) gave about equal control of adult females, but apparently the crawlers were more efficiently controlled with DDT than with derris. Before recommendations are made for the use of DDT, further evidence of control should be obtained.--Stafford (327).

Psyllidae

Paratrioza cockerelli (Sulc.), the potato psyllid

Gesarol A-3 dust gave better results than sulfur-calcium arsenate or sulfur-basic copper arsenate dusts in tests at Las Vegas, N. Mex., in 1944.--Eyer (147).

In a large field test in Nebraska a 3-percent DDT dust and a spray of 4 pounds of 10 percent DDT per 100 gallons of water were equally as effective as the sulfur compounds.--Tate et al. (342).

Five applications of a 3-percent DDT pyrophyllite dust applied at the rate of about 35 pounds per acre per application or five applications of a spray containing 4 pounds of 10-percent DDT in pyrophyllite per 100 gallons of water applied at the rate of about 125 gallons per acre per application greatly reduced the number of both adults and nymphs on potato plants in western Nebraska. DDT remained effective against potato psyllids under field conditions for a relatively long period of time.--Hill (209).

One application of Gesarol A-3 dust gave an average control of 78.5 percent in two tests.--Hibbs (208).

Psylla buxi (L.), the boxwood psyllid

A dust containing 0.8 percent of DDT (A-20 in sulfur) applied on adult boxwood psyllids in two insectary cage tests in July killed 62 and 69 percent of the insects in 38 hours and 81 and 97 percent in 50 hours. There was no revival noted at the end of 72 hours.--Underhill (349).

Psylla pyricola Foerst., the pear psylla

In one orchard dormant miscible oil, containing DDT in solution, applied to give 5.12 ounces of DDT per 100 gallons, showed no advantage over the same oil containing no DDT in control of egg deposition or development of first-brood infestation. In test orchard No. 2, spraying was more timely, no egg laying having occurred prior to application. The DDT formulation reduced egg laying and first-brood nymphs as compared with oil alone. There was no adverse effect on buds, bloom, foliage, yield, or fruit size or condition from DDT in this formulation.--Cleveland (114).

HEMIPTERA

(Suborder Heteroptera)

Anthocoridae

Orius insidiosus (Say)

Orius tristicolor (White)

DDT significantly reduced the number of flower bugs on potatoes in western Nebraska.--Tate et al. (342).

DDT was applied as a 3-percent dust in pyrophyllite and as a spray containing 4 pounds of 10 percent DDT in pyrophyllite per 100 gallons of water in field tests in Nebraska during 1944. Populations of certain beneficial insects, such as Orius spp. were found to be significantly reduced by the DDT dust or spray. The adverse effect of DDT on predatory species seems to be minimized by the fact that this material also controls the major potato pests found in this state. DDT had no injurious effect on potato plants at the strengths used.--Hill (209).

Cimicidae

Cimex lectularius L., the bedbug

A kerosene spray containing 5 percent of DDT is remarkably effective against bedbugs. Mattresses, pillows, springs, and bedframes should be lightly sprayed so that the surface is barely moistened. The advantage of this treatment over fumigation is that reinfestations are eliminated for several months, whereas fumigation kills only the bugs present at the moment.--Freeborn (160).

A severe and long-standing infestation of bedbugs in the animal rooms of a biological research institution in Toronto was reported eliminated by dipping the cages in a 5-percent solution of DDT in refined kerosene, using benzene as an auxiliary solvent.--Ross (306).

At the ninth annual Pest Control Operator's conference held at Purdue University January 15-19, 1945, the results of a demonstration of DDT on bedbugs were tabulated and a 100 percent kill observed.--Anon. (2, 15).

The lethal dose of pure DDT for Cimex was about 10 mg. per square centimeter.--Buxton (100).

A 20-percent DDT dust and 3 percent of DDT in kerosene spray gave excellent control.--N. J. Agr. Expt. Sta. (275).

DDT is a contact poison.--Domenjoz (135).

A bedbug exposed to filter paper bearing a deposit of DDT was found dead the next day.--Vargas et al. (360).

Kaolin containing 1 percent of DDT was dusted on sheets of paper on which the insects were separately placed and covered with a beaker. The time to total paralysis was 340-380 minutes and to death 940-980 minutes.--Sen (311).

Coreidae

Anasa tristis (Deg.), the squash bug

Adults and nymphs were very effectively controlled in replicated plots established in heavily infested commercial plantings by 5 percent of DDT alone and in combination with 5 percent of yellow copper oxide.--Granovsky (187).

A 3-percent DDT dust was effective up to about half-grown bugs; a 10-percent dust controlled adults but injured the plants.--Haseman (203).

Not controlled by a DDT aerosol.--Ditman (133).

In small field tests in California, only 12 adult squash bugs survived 13 days after the last of two applications of a 10-percent DDT dust mixture. In comparable untreated plots the survivors included 221 adults, 20 eggs, and 7 nymphs.--White (373).

In a small-scale test in a greenhouse 4 ounces of DDT in powder suspension per 100 imperial gallons of water was only moderately effective, killing 55 percent of the nymphs within 4 days.--Ross (306).

A 3-percent DDT dust that had no value as an ovicide killed 32 percent of the young nymphs in 2 days but caused no knockdown of adults in cage tests.--Janes (225).

Laboratory tests with a 3-percent dust gave 68 percent control in 48 hours. Nymphs are more susceptible than adults.--Okla. Agr. Expt. Sta. (278).

This bug was kept completely under control when Gesarol A-3 dust was applied at 3- to 5-week intervals. This dust increased the growth of yellow summer crook neck, scallop or pattie pan, and zuchini squashes. --Parker (287).

A test was conducted in the field on mature squash plants already severely damaged by a heavy infestation of half-grown and older nymphs and adults; hence the number present was not known. Dusts containing 1, 2, and 3 percent of DDT and a spray containing 1 pound of DDT in 100 gallons of water were applied. At the end of 24 hours both adults and nymphs were still active in all treatments. After 48 hours very few bugs were seen; careful examination 72 hours after the application showed large numbers killed by each treatment, but a few nymphs and adults survived each one, the largest number of each stage being in the cage receiving the spray.--Lyle (249).

Applications of 3-percent DDT dust to heavily infested squash plants caused nymphs of all sizes to emerge from under leaves. These nymphs

were then heavily dusted. Observations at 24, 48, and 72 hours revealed no dead bugs. This treatment was repeated four times with similar results. Other areas were treated with a 20-percent DDT spray material, but no adults or nymphs were killed. The end of a vine was heavily dusted and 15 adults, 15 last-instar nymphs, and 25 young nymphs were placed on the vine in a cage. At the end of 48 hours only 1 newly emerged adult had died, while nymphs hatching from an egg mass were active.--Gould (184).

A 3-percent DDT dust and a spray containing 1 pound of DDT in 100 gallons of water were tested in preliminary small-plot field experiments on cucurbit crops. DDT spray and dust gave fair control of early-instar nymphs of the squash bug. DDT treatments caused severe plant injury to young acorn squash, cantaloups, and cucumbers. The yield of Hubbard squash was reduced by application of DDT.--N. J. Agr. Expt. Sta. (275).

DDT applied as a dust, or as a spray, either in the form of a suspension or an emulsion proved unsatisfactory against adult squash bugs. The xylene-Triton emulsion of DDT (20 parts DDT, 60 parts xylene, and 20 parts Triton X-100) caused marked terminal and marginal injury of squash plants for all concentrations of DDT above 1 percent.--Haviland (204).

Leptocoris trivittatus (Say), the boxelder bug

Spraying the sides of a heavily infested house with 1 pound of DDT (20 percent DDT-80 percent talc) in 100 gallons of water eliminated the pest for about 1 week.--N. J. Agr. Expt. Sta. (275).

Leptoglossus phyllopus (L.), the leaf-footed bug

This bug occurs in thousands on cowpeas in Mississippi in late summer. Tests were made in which cowpea plants were placed in screened cages, together with 25 adult insects. All the insects died within 4 days when both plant and bugs were dusted with 3 percent DDT, and 24 died within 9 days when the plant only was dusted or sprayed (1 pound DDT in 100 gallons of water) with DDT. In other tests a 2 percent dust applied directly to the adults killed 70 percent in 24 hours and 85 percent in 48 hours.--Lyle (249).

Lygaeidae

Blissus leucopterus (Say), the chinch bug

Fifty chinch bugs were placed in a cage with a film of 3-percent DDT dust on the bottom. After 2 hours the dust caused a mortality of 42 percent, after 4 hours 69 percent, after 5 hours 89 percent, and in 6 hours 100 percent.--Hibbs (208).

In laboratory tests on the chinch bug the percentage of mortality increased with the amount of DDT used. Adults were more susceptible than nymphs. Under unusually heavy dust applications for field conditions, control was only 14.9 percent of the nymphs and 31.1 percent of the adults.--Hamilton (200).

The results of laboratory and field tests seem to show that although DDT is toxic, the action is slow and not comparable to dinitro-o-cresol. A mortality of 100 percent was obtained 1 hour after collecting adult and fifth-instar bugs that had walked through a 1 percent dinitro-o-cresol dust barrier. Only a 33-percent mortality was obtained 24 hours after collecting bugs that had walked through a 5-percent DDT dust barrier. A 10-percent DDT dust applied directly to adult chinch bugs killed 90 percent in 24 hours.--Decker (131).

In field tests in Indiana barrier lines of dust containing 5 percent or more of DDT in pyrophyllite, applied at the rate of about 1 pound per rod, gave excellent protection of corn from immature chinch bugs migrating to it on foot from adjacent wheat. The dust did not act as a repellent or prevent some of the bugs from reaching the corn, but it killed them before they were able to injure the corn materially.

Heavy applications of dusts containing 1 to 5 percent of DDT in pyrophyllite directly to the infested portions of the corn plants and the surface of the soil close to them gave excellent control of the bugs without discernible injury to the plants.--Packard (285).

A 3-percent DDT dust was ineffective.--Haseman (203).

Laboratory tests gave good control only when 3-percent dusts were applied heavily. Adults are more susceptible than nymphs.--Okla. Agr. Expt. Sta. (278).

Oncopeltus fasciatus (Dall.), the large milkweed bug

Same as for Melanoplus femur-rubrum.--AIF (66).

Miridae

Adelphocoris lineolatus (Goeze)

See Lygus oblineatus.--Granovsky (187).

Adelphocoris rapidus (Say), the rapid plant bug

See Lygus oblineatus.--Granovsky (187); Loftin (247).

Adelphocoris superbus (Uhler)

In tests on caged cotton plants, 2.5, 5, and 10 percent DDT gave excellent kill.--Loftin (247).

Calocoris norvegicus (Gmelin)

In a field test on strawberries almost 100 percent control was secured with DDT in acetone suspension with Tergitol Penetrant 7 at both 8 and 16 ounces per 100 imperial gallons of water.--Ross (306).

Chlamydatus associatus (Uhl.)

Same as for Aceratagallia uhleri (Van D.).--Tate et al. (342).

A 3-percent DDT dust and a DDT spray (4 pounds of 10 percent DDT in pyrophyllite per 100 gallons of water) greatly reduced the numbers of adults and nymphs on potato plants in western Nebraska.--Hill (209).

Creontiades femoralis Van Duzee

See Adelphocoris superbus.--Loftin (247).

See Chlorochroa sayi.--Walker (368).

Halticus bracteatus (Say), the garden flea hopper

In cage tests DDT proved highly toxic to adults and nymphs. Males were killed more quickly than females, and fifth instars apparently as readily as third instars. Several hours were required to paralyze or knock down the bugs--usually the majority or all were overcome within 10 to 18 hours, and death generally occurred in 24 to 48 hours. Sprays containing DDT at the low rate of 3 1/8 ounces in 100 gallons, or dusts at 0.4 percent gave around 100 percent kill in 48 hours in nearly all the cage tests. In the field, sprays (6 1/4 ounces of DDT per 100 gallons) and dusts (0.8, 1, and 2 percent) gave highly satisfactory control. The residual effect from a single treatment was remarkable both in the insectary cages and in the field. In the field excellent control was obtained for 8 weeks from a single treatment.--Underhill (349).

Completely controlled with one application of 3-percent DDT dust and reinfestation did not occur for 5 weeks.--Russell (308).

Lygus elisus Van D.

In the Phoenix, Ariz., area a 4.5-percent DDT dust was compared with a pyrophyllite dust containing 0.2 percent of pyrethrins to which equal parts of sulfur had been added. These dusts were tested against three species of Lygus bugs which all infest sugar-beet seed stocks at the same time. In small experimental plots the applications were made at the rate of 50 pounds per acre. The pyrethrum dust mixture was applied twice——once

on May 11 and again on May 19; the DDT mixture was applied on May 11. The results of the applications were recorded on June 1. The DDT dust gave 77 percent control and the pyrethrum dust 67 percent. Germination tests of seed produced on the experimental plots showed 65 percent of viable seed from the undusted plots, 89 percent from the pyrethrum plots, and 91 percent from the DDT plots.--White (373).

In tests on potato plants in western Nebraska, a 3-percent DDT dust and a spray of 4 pounds of 10-percent DDT in pyrophyllite per 100 gallons of water had no effect on the adults but greatly reduced the number of nymphs.--Hill (209).

Same as for Aceratagallia uhleri.--Tate et al. (342).

Same as for Lygus hesperus.--Ross (306); Michelbacher et al. (257).

Lygus hesperus Knight, the western plant bug

An experiment with DDT in California was conducted in an alfalfa field which was heavily infested with Lygus hesperus although a few specimens of L. elisus were present. On the basis of the experiment, a 3-percent DDT dust appears to be very effective in controlling Lygus bugs on alfalfa seed. The results are so promising that further and more extensive work is strongly recommended. In this particular study a 2-acre plot in a 38-acre field was treated. For satisfactory control, two dustings appeared necessary. If, however, the entire field had been dusted, one treatment would probably have sufficed. This certainly would be true if the second dusting in the investigation was rendered necessary by large migrations of adult bugs from the undusted to the dusted area. The following points need further study: (1) Methods of application, (2) timing of application, (3) rate of application, (4) concentration of material to use, (5) effect of the DDT dust on other insects, and (6) natural factors affecting the control of Lygus populations. Although DDT is extremely promising for controlling Lygus bugs on alfalfa seed crops its use should not be recommended until further investigations substantiate the results of this season's study.--Michelbacher et al. (257).

Same as for L. elisus.--White (373).

See Chlorochroa sayi.--Welker (368).

Cotton plants lightly infested were dusted with 3-percent DDT dust (A-3) at the rate of 25 to 30 pounds per acre. After 24 hours no Lygus bugs were found on the plants.--Smith (324).

This bug on guayule succumbed readily to dusts containing 2 to 5 percent of DDT and to emulsions containing from 0.15 to 0.3 percent of DDT.--Craighead and Brown (125).

In laboratory tests foliage was dusted in a bell jar settling chamber and adults were placed on treated host plants, which were changed daily. In 48 hours the kill for Gesarol A-3 dust (3 percent DDT) was 95 percent, for Neocid (10 percent DDT) 92 percent, and for the check 34 percent.--Ross (306).

In laboratory tests vapo-sprays with 1.2, 2.4, and 3.6 percent of DDT were effective when applied to plants on which adult Lygus bugs were subsequently placed or when applied directly on the insects. Four to eight days were required to kill all the bugs.--Lange (242).

Lygus oblineatus (Say), the tarnished plant bug

In tests on caged cotton plants 2.5, 5, and 10 percent DDT gave excellent kill of this species and other Lygus bugs. In field tests the results against the tarnished plant bug were somewhat erratic and control was not so consistent as in cage tests. Control of mixed populations of the tarnished and rapid plant bugs (Adelphocoris rapidus (Say)) in field plots at Tallulah, La., was poor in most instances after six dust applications of 2.5 or 5 percent DDT. In Arizona, in a small-plot experiment at Mesa, seven applications of DDT-pyrophyllite-sulfur (4:36:60) with hand guns resulted in a gain of 1,018 pounds of seed cotton per acre, or 42 percent more than the check, as compared with 13 to 26 percent from four arsenical-sulfur mixtures. Cage and field tests indicated that 2 percent DDT was not so effective as 4 or 5 percent DDT, and the addition of sulfur to the DDT dusts caused a quicker kill of plant bugs and stinkbugs.--Loftin (247).

In greenhouse tests 8 ounces of DDT (powder suspension) in 100 imperial gallons of water gave high kills both by direct contact and as a residual poison on the foliage. In a large-scale test 16 ounces of DDT (in Velsicol emulsion) apparently gave complete protection to chrysanthemums and eliminated the infestation within 4 or 5 days. Adults in the check lived for over a month. On asters in nursery rows Gesarol A-3 dust (3 percent DDT) applied 10 times between July 10 and August 23 gave good but not perfect protection.--Ross (306).

In the laboratory Gesarol A-3 dust controlled both adults and nymphs by the end of 20 hours but aqueous spray was only 87 percent effective.--Hamilton (200).

In laboratory tests a 3-percent DDT dust gave complete control in 20 hours. A 1-percent aqueous spray gave 87 percent control in 20 Hours. --Okla. Agr. Expt. Sta. (278).

Same as for L. elisus.--White (373).

This bug responded to DDT treatments usually by highly significant differences between means.--Granovsky (187).

A DDT aerosol produced excellent kills of the tarnished plant bug on potatoes.--Ditman (133).

A knapsack sprayer was used to apply a 20-percent DDT spray five times on early potatoes and three times on late potatoes. Tarnished plant bugs were not serious.--Gould (184).

Lygus spp.

Tests conducted in 1944 at Phoenix, Ariz., indicated that one application of a 4.5-percent DDT dust produced results practically as good as or better than two applications of pyrethrum extract-sulfur dust previously recommended for the control of Lygus bugs on sugar beets grown for seed. DDT is very toxic to beneficial insects such as ladybeetles, lacewings, and parasites which occur in beet fields and which are responsible for holding aphid infestations in check.--Hills (210).

Laboratory tests conducted at Phoenix, Ariz., indicated that 5 percent DDT and 1 percent dinitro-o-cresol were equally as good as the pyrethrum-extract sulfur dust recommended for Lygus control on seed beets, although somewhat slower in their action. Other tests showed that both sabadilla and DDT were effective against Lygus adults, primarily L. oblineatus (Say). The sabadilla killed much more rapidly, both at the 20-percent and 5-percent strengths, than did the 3-percent DDT. DDT dusts containing sulfur gave somewhat better results than DDT in pyrophyllite. DDT produced the highest Lygus mortality of any of the materials tried in the field and produced no detrimental effect on the plants. Plots treated with this material produced a better quality of seed than any plots treated with the pyrethrum extract-sulfur dust.--Hills and McKinney (211).

In a field-plot test of three insecticidal dusts on seed alfalfa in Utah, 10 percent of DDT in pyrophyllite was found to be highly toxic to these bugs, effective for weeks after application, and definitely promising as a satisfactory control of Lygus bugs. DDT was outstandingly successful in accomplishing Lygus control because of its ability to remain toxic throughout the period required for flowering and podding of the seed crop. One dusting of the alfalfa growth reduced and held the nymphs to negligible numbers. Sabadilla and pyrethrum dusts gave substantial population reductions, but with rapid hatching of eggs the population of nymphs was speedily rebuilt to menacing strength. The DDT residues on samples of dusted alfalfa exceeded the DDT tolerance of 7 p.p.m., but in view of the high degree of Lygus control secured it seems likely that dosages can be reduced sufficiently to bring the DDT residues within the tolerance and still maintain satisfactory Lygus control and economically profitable seed production.--Lieberman (245); also Packard (285).

In preliminary tests with DDT favorable results were obtained in the control of certain sucking bugs that cause distortion of peaches.--Baker and Porter (81).

Psallus ancorifer (Fieber), an onion seed plant bug

In early July, in the Willamette Valley, Gesarol A-3 dust was applied with a hand duster at the rate of 35 pounds per acre to a 25- by 50-foot plot of onions raised for seed. An infestation of 25 to 75 bugs per seed head was counted before the dust was applied. After 48 hours there were no live bugs in the dusted block. A number of dead bugs were found down deep in some of the heads. The infestation in the remainder of the field appeared to be the same as on the date the dust was applied to the test plot--25 to 75 bugs per head--except for a few rows just east of the experimental plot, where there were very few live bugs and a number of dead ones.--Thompson (346).

Psallus seriatus (Reut.), the cotton flea hopper

In experiments in Texas several concentrations and combinations of DDT were compared with sulfur and the standard 1:2 mixture of calcium arsenate and sulfur for control of this insect. At Port Lavaca, on heavily infested plots dusted five times at the rate of 12 to 13 pounds per acre, 2 percent DDT gave a reduction in population about equal to that given by the 1:2 calcium arsenate-sulfur mixture. At Raymondville and Brownsville, on plots dusted once, the reduction of flea hopper populations in 4 to 6 days was about one-third greater from 2.5 and 5 percent DDT than from sulfur or 1:2 calcium arsenate-sulfur. At Waco, plots dusted four times showed no significant differences in population between 4 percent DDT, 2 percent DDT, and calcium arsenate-sulfur. The yield from each treatment was greater than from the check, the yield from the 2 percent DDT being significantly greater than that from the calcium arsenate-sulfur but not significantly better than that from the other treatments containing DDT.--Loftin (247).

Field tests using 3-percent DDT dust at 14 pounds per acre gave 95.3 percent control for the nymphs and 8.7 percent for the adults. Laboratory tests gave complete control for both adults and nymphs.--Okla. Agr. Expt. Sta. (278).

In the laboratory Gesarol A-3 at a dosage of about 60 mg. in a quart fruit jar killed all adults and nymphs. In field tests 14 pounds of Gesarol A-3 dust per acre killed 8.7 percent of the adults and 95.3 percent of the nymphs.--Hamilton (200).

One application of 3-percent DDT dust made July 18 on cotton, at the rate of 12 pounds per acre, gave 77 percent control of fleahoppers the first week, 36 percent the second week, and 34 percent the third week. This was better control than that obtained with either sulfur or sabadilla during the same period.--Hibbs (208).

Same as for Thrips tabaci.--Smith (324).

Nabidae

Nabis alternatus Parshley

Nabis ferus (L.)

In western Nebraska potato fields a 3-percent DDT dust and a spray containing 0.4 pound of DDT per 100 gallons significantly reduced the number of nabids.--Tate et al. (342); also Hill (209).

A 10 percent DDT-pyrophyllite dust reduced the population of nymphs and adults of Nabis ferus in an alfalfa field.--Lieberman (245).

Nabis ferus would alight on small cotton plants that had been dusted with a 3-percent DDT dust (A-3) at the rate of 25 to 30 pounds per acre, but moved about and did not feed; after a few seconds the action of the hind legs became abnormal, but the insect was able to fly 40 or 50 feet. After 24 hours there were no Nabis ferus.--Smith (324).

Acrosternum hilare (Say), the green stinkbug

Gesarol A-3 dust was slow in its action in cage tests. A very heavy application caused 73 percent knockdown in 72 hours.--Ewart (145).

Pentatomidae

Chlorochroa ligata (Say), the conchuela in the Southwest

Same as for Adelphocoris superbus.--Loftin (247).

Chlorochroa sayi Stål, the Say stinkbug

At Phoenix, Ariz., on May 31, an 80-acre field of garden beans infested with Lygus bugs and the Say stinkbug was treated with 5- and 2-percent DDT dust mixtures. On June 3 the control of Lygus was recorded as 100 percent in both plots; the numbers of these species taken by 50 sweeps of an insect net in a comparable undusted plot increased from 83 on May 31 to 307 on June 3. Reduction of the Say stinkbug on June 3 was 92 percent for the 5-percent dust and 79 percent for the 2-percent dust. The percentage of viable seed produced was 92 in the 5-percent DDT plot and 88 in the 2-percent DDT plot as compared with 73 percent in the undusted plot.--White (373).

Laboratory tests conducted at Phoenix, showed that 1 percent dinitro-o-cresol and 10 percent DDT were equally effective, the former acting much more rapidly than the latter. DDT gave fair results against this bug in experimental plots, although these data are limited.--Hills and McKinney (211).

Insects swept from alfalfa were lightly dusted with 3-percent DDT dust and held in an insect net with alfalfa cuttings over night. By this method complete kills were obtained of all Lygus bugs, two species of thrips, and a leafhopper, Empoasca sp., but it was not efficient against other insects. The 3-percent dust gave no indication of being toxic to the Say stinkbug.--Smith (324).

A field of Arizona cotton which received one application of a 2-percent DDT dust and five applications of a 4 percent DDT-60 percent sulfur dust made by airplane, produced 30 percent more lint per acre than did a field treated with the standard sulfur-paris green mixture, and 100 percent more than did an untreated check plot.--Welker (368).

Same as for Adelphocoris superbus.--Loftin (247).

Euschistus impictiventris Stål, the brown cotton bug

Same as for Adelphocoris superbus.--Loftin (247).

See Chlorochroa sayi.--Welker (368).

Euschistus servus (Say)

This bug is often numerous on cotton, okra, beans, and other crops. Practically no mortality occurred within 72 hours after a group of adults was dusted with 2 percent DDT.--Lyle (249).

Murgantia histrionica (Hahn), the harlequin bug

Though DDT showed promise against caged harlequin bugs, it was not effective in the field. Rotenone was very effective and apparently a dust containing 0.4 percent of rotenone and 2 percent of Lethane was as good as a stronger mixture.--Bissell (87).

Adult bugs carefully held by forceps were touched on the ventral side only with fresh dust (Gesarol A-3) or with dust that had been exposed for 24 hours in an open jar. The bugs were then placed in cages with untreated check insects for comparison. The fresh dust produced 72 percent and 40 percent better knock-down at the end of 24 and 96 hours, respectively, than did the exposed dust.--Ewart (145).

Not controlled by a DDT aerosol.--Ditman (133).

In several indoor cage tests all harlequin cabbage bugs died within 36 to 48 hours when placed on potted kale plants previously dusted with a 3-percent DDT dust. Similar lots of bugs on untreated plants were alive and active after the same period of time.--Cartwright (108).

The harlequin bug was confined in field cages on cabbage at Hendersonville, N. C. A 10-percent DDT dust killed only 64 percent of the adult bugs in 3 days. In small tests at Alhambra, Calif., a 2.5-percent DDT dust killed 35 percent in 3 days and 86 percent in 5 days. --White (373).

Solubea pugnax (F.), the rice stinkbug

A 10-percent DDT dust applied to adults in screen-wire cages at the rate of about 10 pounds per acre-application gave 88.5 percent control of adults after 2 days and 82.4 percent after 4 days.--Ingram et al. (222).

Thyanta custator (F.)

Same as for Adelphocoris superbus.--Loftin (247).

Same as for Chlorochroa sayi.--Smith (324); Welker (368).

Corythucha cydoniae (Fitch), hawthorn lacebug

Gesarol A-3 dust was effective against young and adults but not against eggs. A dust containing 0.4 percent of rotenone plus 2 percent of Lethane gave a quicker and more thorough clean-up.--Bissell (87).

Gargaphia solani Heid.

Two applications of a DDT aerosol caused 100 percent reduction of the eggplant lacebug. The second application killed newly hatched young.--Ditman (133).

Lacebugs

A 3-percent DDT dust was effective.--Haseman (203).

In one cage test on lacebugs from Pyracantha and cotoneaster ornamental shrubs a 2-percent DDT dust (A-2) killed 76 percent of the bugs in 38 hours and 90 percent in 72 hours.--Underhill (349).

In laboratory tests DDT dusts (1, 2, and 3 percent) and a spray (1 pound of DDT to 100 gallons) killed most of the adults and nymphs within 24 hours and after 5 days only a few adults were alive. On September 21 a heavily infested shrub was dusted with 2 percent DDT and 4 days later the bugs were still numerous. By October 10 the shrub was again heavily infested and was dusted with 3 percent DDT. Examination 48 hours later showed that most of the bugs were dead, and by October 25 very few were seen on the treated plant but they were numerous on untreated plants.--Lyle (249).

Triatomidae

Rhodnius sp.

Pieces of filter paper were treated with a range of doses of pure DDT, using a volatile solvent, so that the surfaces presented to the insects were dry. All insects were exposed at the same temperature and for the same period. The lethal dose for Rhodnius sp. was much above 10 mg. per square centimeter of DDT.--Buxton (100).

ANOPLURA

Haematopinidae

Haematopinus asini (L.), the horse sucking-louse

DDT is a contact poison.--Domenjoz (135).

Haematopinus eurysternus Nitz., the short-nosed cattle louse

Preliminary laboratory tests indicated that lice are very susceptible to DDT. A heavily infested cow was dusted with Gesarol A dust and an examination 2 days later revealed 100 percent kill of short-nosed cattle lice.--Ross (306).

Three 2-year old heifers moderately infested with lice were treated with a 10 percent DDT-pyrophyllite dust. In 24 hours more than 90 percent of the lice had been destroyed; 3 weeks later a light infestation of newly hatched lice was observed and after 5 weeks the infestation had disappeared completely.--Munro and Knapp (269).

Same as for H. asini.--Domenjoz (135).

Haematopinus piliferus

Same as for H. asini.--Domenjoz (135).

Unidentified species

Benzene hexachloride proved at least as effective as DDT against guinea pig lice.--Taylor (343).

Haematopinus suis, the hog louse

Hog lice were controlled by spraying hogs twice at 14-day intervals with a 1-percent DDT suspension (8 pounds of 10-percent DDT in pyrophyllite plus 2 ounces of wetting agent in 10 gallons of water). DDT does not destroy eggs and the animals suffered no detrimental effect.--Shull et al. (315).

Pediculidae

Pediculus humanus corporis Deg., the body louse

Pediculus humanus humanus L., the head louse

An account of the mass delousing of the population of Naples in the winter of 1943-44 by the typhus team of the Rockefeller Foundation. --Fosdick (158).

All body lice were dead after 96 hours' exposure to cloth impregnated with 10 p.p.m. of DDT, and all head lice after 76 hours' exposure to cloth impregnated with 1 p.p.m. of DDT.--Domenjoz (135).

The DDT preparation Neocid was found effective against lice in the winter of 1941-42 by Domenjoz working in the pharmacological laboratories of Geigy Co., and soon after systematic tests of this same material in the Hygienic Institute of the University of Zurich proved it to be 100 percent effective. On September 18, 1942, Mooser lectured to the first Swiss Army Corps on typhus and its prevention, reporting laboratory tests with Neocid on lice, and spoke of the possibility of using this material to combat typhus epidemics. In the Swiss Army DDT has been used since the early part of 1943 for vermin control, and in camps of refugees since the summer of 1942. In September 1942 Geigy placed at the disposal of the Service de Santé of the Swiss Army a ton of Neocid powder.--Mooser (264).

Kaolin containing 1 percent of DDT was dusted on sheets of paper on which the insects were separately placed and covered with a beaker. The time, in minutes, before total paralysis was 160 to 200; and before death 820 to 860.--Sen (311).

"The Geigy company in Switzerland was the first to discover the value of preparations containing DDT for the control of head and body lice, and I have seen their advertisements, dating from the latter part of 1942. We in London also discovered that DDT is very effective against lice; Busvine's experiments in the early months of 1943 indicated a toxicity to lice about ten times that of the thiocyanates. A small amount of work has been carried out in Britain, using emulsions to impregnate the hair of the head. Dr. J. R. Busvine is good enough to let me say that a dose of 0.2 gram of DDT completely proofs the head for a week but after a fortnight is beginning to fail in some cases."--Buxton (100).

A 10-percent DDT dust in talc, applied to the inside of the clothing at the rate of about 1 1/2 ounces per individual, will adequately control body lice.--Freeborn (160).

The great potential importance of DDT as an army insecticide was first revealed in England by work carried out in the Department of Entomology, London School of Hygiene and Tropical Medicine, which showed that it possessed a powerful lethal action on lice.--Heilbron (205).

Benzocaine, a local anaesthetic, is being incorporated in the DDT louse powder to allay itching. Solution to the problem of making DDT louse powder kill the lice faster is more elusive.--Anon. (3).

On February 21, 1945, it was announced that the Army's delousing emulsion NBIN would be used to treat a limited number of head lice cases among school children in Washington, D. C. [This emulsion, when diluted for use, contains 1 percent of DDT, 2 percent of benzocaine, 11 1/3 percent of benzyl benzoate and 2 1/3 percent of Tween 80, an emulsifier.] --Anon. (23).

The use of DDT powder for the destruction of body lice was described by Ahnfeldt (70).

More pyrethrum will go into Army and Navy louse powders to speed up the present slow action of plain DDT powders.--Peaker (290).

Phthirus pubis (L.), the crab louse

DDT is a contact poison.--Domenjoz (135).

COLEOPTERA

Anobiidae

Lasioderma serricorne (F.), the cigarette beetle

See Ephestia elutella.--White (373).

Bostrichidae

Rhizopertha dominica (F.), the lesser grain borer

The addition of 0.005 percent of technical DDT to seed wheat (12-percent moisture content) killed all introduced adults at the end of the first week. In another test the addition of sufficient 3 percent DDT-pyrophyllite dust to give a concentration of 15 p.p.m. of DDT in the wheat caused 100 percent mortality in 1 week.--Cotton et al. (120).

Bruchidae

Bruchus brachialis Fahraeus, the vetch bruchid

DDT is the only control yet found effective.--Burtner (98).

On hairy vetch in Oregon two applications of a 5-percent DDT dust at rates of 22 to 25 pounds of the dust per acre as the pods began to set and 15 days later gave excellent control of the vetch bruchid without visible injury to the plants, and were significantly better than two applications of a dust containing 1 percent of rotenone at approximately the same rates per acre.--Packard (285).

Bruchus pisorum (L.), the pea weevil

In laboratory experiments at Moscow, Idaho, in 1943, relatively low mortalities of the pea weevil were obtained with a 10-percent DDT dust when the weevils were transferred from treated cages to clean cages 5 minutes after treatment. Later tests showed that the mortality could be increased by retaining the insects in the treated cages for a longer time. In 1944 field experiments were conducted on plots 24 feet wide and located end to end around the edges of large fields of peas grown for seed. In 21 replicates a 5-percent DDT dust reduced the adult pea weevil infestation 99 percent in 2 days, whereas a 0.75-percent rotenone dust reduced the infestation 98 percent in a like period. In these tests the insecticides were applied with a power duster at the rate of 30 pounds of the DDT dust mixture and 20 pounds of the rotenone dust mixture per acre. In 7 replicates 2.0 percent of the dried peas in the DDT plots were weevily as compared with 2.7 percent in plots where rotenone dust was used.--White (373).

The pea weevil was controlled by eight applications of 5-percent DDT in light summer spray oil, average about 1/2 gallon per acre, with a hand atomizer from June 6 to August 1.--Gray (188).

Byturidae

Byturus tomentosus F., the raspberry fruitworm

In England a laboratory preparation of DDT (75 percent p-p' compound) containing 0.05 percent of Agral 2 and 0.025 percent of sulfite-lye, and two proprietary preparations were tested. The proprietary preparations were not exactly alike. In 1943 a product of Swiss origin was used. This contained 5 percent of DDT on a base consisting of chalk and bentonite, together with a wetter of the Nekal type (an alkyl naphthalene sulfonate). It settled out from suspension so rapidly that its use in this trial was possible only because of the very efficient agitation available in the spraying machine. In 1944 a British product was used which also contained 5 percent of DDT (77 percent p-p' compound). However, the DDT in this product was on a base of china clay with some bentonite, together with alkyl naphthalene sulfonate and a dinaphthylmethane sulfonate as auxiliaries.

DDT at 0.025 percent or at 0.05 percent gave as good control as a Lonchocarpus spray containing approximately 0.011 percent of rotenone.

Although the difference between treated and control plots was highly significant, there was no significant difference in the results obtained with either concentration. In 1943 a single spraying with each one of the materials was only moderately effective against a fairly heavy infestation, whereas in 1944 double spraying gave excellent control of a lighter infestation irrespective of the spray used. In no case was there any evidence of phytotoxicity. The proprietary material, which formed a better suspension, left a deposit on the fruit that made the earliest pickings unsalable.--Shaw (313).

Cerambycidae

Acanthocinus spp., wood borers

Monochamus spp., wood borers

Preliminary work with DDT at Beltsville, Md., Saucier, Miss., and Berkeley, Calif., indicates that it may be an effective insecticide for use on valuable logs to prevent the attack of bark beetles, ambrosia beetles, and wood borers. Protection lasting 2 months was obtained with 2- to 10-percent solutions in Diesel oil or kerosene. Wood borers such as Monochamus and Acanthocinus were more easily killed or repelled than bark beetles, and particularly ambrosia beetles. The latter require concentrations of at least 5 percent. The tests in Mississippi were less effective than those at Beltsville, the great difference in rainfall probably being an important factor.--Craighead and Brown (125).

Megacyllene robiniae (Forst.), the locust borer

Adults were killed when DDT was applied as an emulsion either to the goldenrod on which the beetles feed or to the stems of locust trees prior to oviposition.--Craighead and Brown (125).

Chrysomelidae

Cerotoma trifurcata (Forst.), the bean leaf beetle

Controlled on green and yellow string beans with one application of Gesarol A-3 dust.--Parker (287).

In a small patch of beans grown in a victory garden this beetle was controlled by 5 percent of DDT in pyrophyllite.--Granovsky (187).

Chaetocnema pulicaria Melsh., the corn flea beetle

Good protection of young sweet corn from the corn flea beetle and considerable reduction in the bacterial wilt which it transmits were obtained in experimental plots of a wilt-susceptible and a wilt-resistant variety at Beltsville, Md. Following 5 applications of 0.66 percent DDT

spray, obtained by adding 10 percent DDT dust to water containing a small percentage of spreader, at intervals of 3 to 6 days, only 2 beetles were found on a treated row of corn as compared with 128 on an untreated row. In the susceptible variety a much better stand was maintained in the treated rows than in the untreated rows.--Packard (285).

Crioceris asparagi (L.), the common asparagus beetle

C. duodecimpunotata (L.), the spotted asparagus beetle

In greenhouse experiments from 16 to 32 times as much DDT was required to kill adults of the spotted asparagus beetle as the common asparagus beetle. This difference seemed to hold for both stomach and contact sprays. The stomach-poison sprays were made with DDT-talc-Orvus and were applied to the plant only, whereas the contact sprays were made with DDT, Triton X 100 and Velsicol AR-60, and were applied to the beetles only.--Ross (306).

Diabrotica duodecimpunctata (F.), the spotted cucumber beetle

Both 3-percent DDT dust and 35-percent cryolite dust gave equally satisfactory control of cucumber beetles. Young squash plants and pumpkin plants were severely stunted by DDT, the acorn squash being most susceptible. Young cucumber plants were stunted to some extent.--Tate et al. (342).

A 3-percent DDT dust was effective.--Haseman (203).

In greenhouse tests DDT applied as a stomach poison, 4 ounces in powder suspension per 100 imperial gallons of water, gave excellent control of adults.--Ross (306).

Indications are that DDT may be effective against the 12-spotted cucumber beetle.--Burtner (98, 99).

Same as for Anasa tristis.--Granovsky (187).

During the second week of growth 30 hills of early cucumbers received 7 applications of 3-percent DDT dust. Cucumber beetles were kept under control, but some injury was caused to the plants. The margins of older leaves turned yellow and remained that way all summer. Harvest on these plants was delayed somewhat as compared with the remainder of the patch which was treated with cryolite. An infestation of lice developed on the DDT-treated plants first. After 6 applications of cryolite, 60 hills of late cucumbers (about 12 inches high) were divided into 2 plots, 1 receiving 3-percent DDT dust and the other 20-percent Gesarol spray. A total of 5 applications was made. No injury occurred

on the sprayed plots and yellowing was only faintly noticeable on the dusted plots. Melon lice started on these plants before harvest and hardly a cucumber was picked. The beetles were not troublesome. Two early treatments of cryolite and five applications of either 3-percent DDT dust or 20-percent Gesarol spray on 80 hills of cantaloups caused no vine injury and no beetle trouble. An infestation of melon lice developed on these plants. On 15 hills of squash the 3-percent dust caused rather severe yellowing of the foliage. No trouble from beetles, but a severe louse infestation developed on all plots.--Gould (184).

A 3-percent DDT dust and a spray containing 1 pound of DDT in 100 gallons of water were tested in preliminary small-plot field experiments on cucurbit crops. The DDT spray and dust gave outstanding control of striped and 12-spotted cucumber beetles, fair control of early-instar nymphs of squash bug, and control comparable to 1-percent rotenone dust on squash borer. They were both inferior to a 1:800 nicotine-soap spray against melon aphid. DDT treatments caused severe plant injury to young acorn squash, cantaloups, and cucumbers, and the yield of Hubbard squash was reduced.--N. J. Agr. Expt. Sta. (275).

Diabrotica 11-punctata Mann., the 11-spotted beetle

In laboratory tests adult beetles were very sensitive to DDT in any form. In most cases, the time required for a 100 percent kill was the same whether the insects were directly treated or were placed on treated foliage. The beetles reacted to DDT within an hour, but several days were usually required for a final kill. There was no consistent difference between the percentages of DDT in the oils for the range 0.3 to 3.6 percent. The 3-percent dust was superior to the 1-percent dust.--Lange (242).

Controlled by eight applications of 5-percent DDT in light summer spray oil, average about 1/2 gallon per acre, made by hand atomizer from June 6 to August 1.--Gray (188).

A 3-percent DDT dust and atomized oil containing 5 percent of DDT were effective. A bait spray containing 1 percent of DDT and 10 percent of brown sugar was more effective than one containing 10 percent of barium fluosilicate and the same amount of brown sugar.--Gray and Schuh (189).

Four specimens swept from alfalfa were lightly dusted with 3-percent DDT dust (A-3) and held in an insect net with alfalfa cuttings over night; all were killed.--Smith (324).

Diabrotica longicornis (Say), the corn rootworm

A 3-percent DDT dust was effective against the adults.--Haseman (203).

Diabrotica vittata (F.), the striped cucumber beetle

This beetle was completely controlled with Gesarol A-3 dust. The vines produced until late summer, an unheard-of condition previously.--Parker (287).

The cucumber beetle was susceptible to DDT (Gesarol A-20) under laboratory conditions. The DDT was added to water at the rate of 0.8 pound in 100 gallons.--Fluke and Pond (157).

Same as for Anasa tristis.--Granovsky (187).

Same as for Diabrotica duodecimpunctata.--Tate et al. (342); Haseman (203); Gould (184); N. J. Agr. Expt. Sta. (275).

In greenhouse tests powder suspensions as a stomach poison gave 100 percent kill at DDT 4 ounces and over 75 percent kill at 1 ounce per 100 imperial gallons of water.--Ross (306).

Epitrix cucumeris (Harr.), the potato flea beetle

At Jefferson, N. C., plots treated with a 3-percent DDT dust yielded more potatoes than did any of five other differently treated plots, but the tuber yield in the 1-percent DDT dust plot was the lowest. No injury to potato foliage was observed. The seasonal average of flea beetle holes of leaf surface was lowest in the 3-percent and highest in the 1-percent DDT dust plots.--Kulash (240).

Extensive tests made by the Oregon Agricultural Experiment Station are conclusive enough to warrant recommendation of DDT for control of the potato flea beetle.--Burtner (98).

A DDT spray (A-20), used at the rate of 2 pounds to 50 gallons of water, reduced feeding scars about as well as calcium arsenate and cryolite when used at the same dosage, but was not so good as a 2-4-6-50 calcium arsenate-bordeaux spray. However, the DDT-sprayed plots produced as high a yield as did those sprayed with the bordeaux.--Anderson (73).

Same as Macrosiphum solanifolii (Ashm.).--N. J. Agr. Expt. Sta. (275).

DDT is being recommended for its control in Oregon.--Childs (110, p. 68).

DDT was released in June 1945 for the control of the potato flea beetle in Oregon.--Jenkins (227).

A DDT aerosol produced excellent kills.--Ditman (133).

The pest is effectively controlled by a concentration as low as 1 percent of DDT, especially when the dust actually hits the insects. Within 24 hours a nearly complete mortality is obtained.--Granovsky (185, 186, 187).

A knapsack sprayer was used in making 5 applications of 20-percent DDT spray on early potatoes and 3 applications on late potatoes. Potato leafhopper counts on the treated plants varied considerably, but the population was definitely lower on DDT plots than on the check. Potato flea beetles, Colorado potato beetles, blister beetles, and tarnished plant bugs were not serious.--Gould (184).

Four pounds of a wettable powder containing 25 percent of DDT per 100 gallons of water, applied at the rate of 125 gallons per acre, was more effective than bordeaux (8-12-100) in reducing flea beetles and the number of their feeding holes.--Gui (192).

Although DDT was responsible for an average reduction of about 80 percent in flea beetle feeding, there was no apparent effect on the number of flea beetles on the plots adjacent to those treated with DDT.--Wilson and Sleesman (377).

Although a 3-percent DDT dust was not so effective as a 2-5-6-50 calcium arsenate-bordeaux spray in keeping flea beetles from feeding on potato foliage, bordeaux-DDT merits further testing.--Walker (365).

Epitrix fuscula Crotch, the eggplant flea beetle

This insect was controlled when Gesarol A-3 dust was applied at 3- to 5-week intervals to eggplants.--Parker (287).

Six applications of 3-percent DDT dust made between June 14 and July 28 gave very effective control; the dust was slightly superior to 35 percent cryolite.--Tate et al. (342).

Same as for E. cucumeris.--Gui (192).

Epitrix hirtipennis (Melsh.), the tobacco flea beetle

In a field experiment at Oxford, N. C., a 5-percent DDT dust gave 66 percent control based on a comparison of the number of beetles surviving on treated and untreated plots following the first application, and 59 percent following the second application. Three 60-percent cryolite dusts, each in a different diluent, gave control ranging from 39 to 54 percent.--White (373).

Same as for E. fuscula.--Tate et al. (342).

E. parvula (F.)

Same as for E. cucumeris.--Gui (192).

E. subcrinita (Lec.), the western potato flea beetle

Same as for E. tuberis.--White (373).

Epitrix tuberis Gentner, the tuber flea beetle

DDT dust was placed in soil around potato plants at a depth of about 2 inches for controlling tuber flea beetles. Marked reductions in larval injury to tubers was obtained with both a 3-percent and a 10-percent dust applied at the rate of 200 pounds per acre. Some control was indicated by applications of 100 pounds per acre, but no improvement was shown by 50-pound applications. In the laboratory a 3-percent DDT dust gave 81 percent mortality of adult beetles as compared with 41 percent with cryolite-sulfur dust, which is the dust now being used for flea beetle control in western Nebraska.--Tate et al. (342).

A 3-percent DDT dust is recommended in Oregon for the control of this beetle on potatoes. Atomized oil containing 5 percent of DDT is also effective.--Gray and Schuh (189).

Experiments comparing cryolite, calcium arsenate, and DDT dust mixtures against the tuber flea beetle and the western potato flea beetle were conducted in the Yakima Valley, Wash. The tuber flea beetle, formerly designated as the western form of E. cucumeris (Harr.), was the predominant species. Four applications of a 10-percent DDT dust at the rate of 17 pounds compared with a 70-percent cryolite dust mixture applied at 10 pounds per acre-application yielded the following results: DDT plots 42 percent damaged tubers; cryolite plots 54 percent damaged tubers. The total yield of marketable potatoes was about the same for both treatments.--White (373).

Epitrix spp.

Same as for Bruchus pisorum.--Gray (188).

A 3-percent DDT dust was effective against flea beetles on eggplant. --Haseman (203).

Eggplants in late August had a heavy population of flea beetles. One treatment of 20-percent DDT spray applied with a knapsack sprayer appeared to have no effect on the population, as observations 24 and 48 hours later revealed the beetles still feeding on the residue-covered plants.--Gould (184).

Fidia viticida Walsh, the grape rootworm

In preliminary tests with DDT favorable results were obtained in the control of this insect.--Baker and Porter (81).

Leptinotarsa decemlineata (Say), the Colorado potato beetle

In a small-scale test 100 percent mortality resulted when late-instar larvae were lightly and evenly coated with Gesarol A-3 dust (3 percent DDT), and no feeding was done after the dust was applied. In other laboratory tests potato foliage was treated in a bell-jar settling chamber and adult potato beetles were added. The treated foliage was changed daily. Mortality after 96 hours was 36 percent for Neocid No. 10 dust, 34 percent for Gesarol A-3 dust, and zero for the check. In a field test on lightly infested potatoes one application of Gesarol A-3 dust left an average of 42 living larvae per 45 plants 1 week after application whereas a bordeaux-calcium arsenate spray left an average of 3 larvae per plant.--Ross (306).

A 3-percent DDT dust was effective.--Haseman (203).

In the laboratory a 2-percent DDT aqueous spray killed 74 percent of adults and larvae in 24 hours.--Hamilton (200).

Laboratory tests with a 3-percent dust gave 74 percent control in 24 hours.--Okla. Agr. Expt. Sta. (278).

This insect was controlled when Gesarol A-3 dust was applied at 3- to 5-week intervals to potatoes.--Parker (287).

A 3-percent DDT dust was very effective in controlling larvae and adults, and a 1-percent dust, although less effective, was superior to other materials. Gesarol Oil Spray SH-5 applied at the rate of 1:200 was ineffective. No injury to potato foliage was observed.--Kulash (240).

The tops of tomato seedlings were dipped in suspensions containing 1 pound of DDT and 4 pounds of lead arsenate per 100 gallons. In one series of tests 1 pound of soybean flour and in another "Orthol K" medium summer oil emulsion (1/4 percent actual oil) per 100 gallons were used as a sticker. Both treatments were equal in preventing feeding by the potato flea beetle and the Colorado potato beetle. The DDT-soybean flour treatment caused moderate yellowing and stunting of plants, whereas the DDT-oil treatment caused severe yellowing and stunting. The growth of DDT-treated plants was retarded 10 to 14 days when compared with lead arsenate-treated plants and untreated check plants. The DDT-treated plots yielded 19 tons per acre whereas the calcium arsenate plots yielded 22 tons.--N. J. Agr. Expt. Sta. (275).

A dust containing 5 percent of DDT and copper applied twice at the rate of 20 pounds per acre-application gave the highest yield of potatoes and caused the highest mortality of insects, including the Colorado potato beetle, of any material tested (arsenical, Dithane, DN dust plus copper, sabadilla plus copper, and copper-lime dust).--Munro and Redman (270).

A knapsack sprayer was used to apply a 20-percent DDT spray five times on early potatoes and three times on late potatoes. Potato leafhopper counts varied considerably, but the population was definitely lower on the DDT-treated plots than on the check. Potato fleabeetles, Colorado potato beetles, blister beetles, and tarnished plant bugs were not serious.--Gould (184).

In laboratory tests DDT spray killed adults and young larvae after 24 to 36 hours. The DDT (Gesarol A-20) was added to water at the rate of 0.8 pound in 100 gallons.--Fluke and Pond (157).

Gesarol A-3 dust gave complete control of adults and larvae.--Fletcher (155).

This pest was killed with remarkable ease in the adult and larval stages within 24 or 36 hours after dusting with a 5-percent DDT dust. From 2 years of experiments, it is evident that while DDT has a considerable residual value on foliage under field conditions, it does not possess very long residual properties outdoors as compared with indoors. The combination of DDT with 5 percent of yellow copper oxide gave somewhat better control of most of the potato insects than the same concentrations of DDT alone.--Granovsky (187).

A DDT aerosol produced excellent kills.--Ditman (133).

Paria canella (F.), the strawberry rootworm

In greenhouse tests, 8 ounces of DDT per 100 imperial gallons of water gave 100 percent kill of adults both by stomach poisoning and by contact.--Ross (306).

In the laboratory a water suspension of 4 pounds of 20-percent DDT powder with wetting agent (A-20) per 100 gallons of water was poured on a glass plate and allowed to dry. A white film was visible on the plate when the spray dried. After 291 days strawberry rootworms were caged with the plates and clean strawberry leaves. After 4 days all the insects were on their backs; after 5 days, all were dead. In a similar test a 3-percent dust (A-3) was also applied as a thin deposit on a glass plate, and insects were caged immediately with the plate and clean strawberry leaves. All the insects were dead at the end of 5 days, the speed of killing being no greater than that of the aged spray deposit described above.--Smith (325).

Phyllotreta spp.

Controlled by eight applications of 5-percent DDT in light summer spray oil, average about 1/2 gallon per acre, made with hand atomizer from June 6 to August 1.--Gray (188).

Adults were placed on foliage which had been treated in a bell jar settling chamber. The treated foliage was changed daily. Mortality after 48 hours was 99 percent for Gesarol A-3 dust, 91 percent for Neocid A-10, and 16 percent for the check.--Ross (306).

One application of Gesarol A-3 dust to turnips removed an infestation of striped flea beetle in 2 days.--Janes (225).

Coccinellidae

Adalia bipunctata (L.), the two-spotted lady beetle

Under laboratory conditions adults are quite readily killed by walking over surfaces sprayed with a water suspension of DDT. The DDT (Gesarol A-20) was added to water at the rate of 0.8 pound in 100 gallons of water. --Fluke and Pond (157).

Epilachna varivestis Muls., the Mexican bean beetle

Not controlled by a DDT aerosol.--Ditman (133).

In cage tests in New Mexico a pyrophyllite dust containing 3 percent of DDT killed 93.8 percent of the larvae in 72 hours. In field tests this dust gave results as favorable as those of a 0.5 percent rotenone-talc dust.--Eyer (147).

Four applications of 3-percent DDT dust with sulfur added were made with a hand duster to bean plants infested with a few Mexican bean beetles and many potato leafhoppers. Dry weather eliminated the Mexican bean beetle population and reduced the yield from the plots. The yield varied considerably and that of the DDT-treated plots was below that of the untreated area. The DDT dust had no harmful effect on the plants.--Gould (184).

A 3-percent DDT dust and a spray containing 1 pound of DDT in 100 gallons of water were tested against standard treatments. The DDT treatments were inferior to a 0.4-percent rotenone dust in the control of the Mexican bean beetle.--N. J. Agr. Expt. Sta. (275).

As in 1943, experiments in 1944 showed that DDT applied as a dust or as a spray suspension had little toxic effect on the Mexican bean beetle. In field experiments conducted in North Carolina, the control from a 10-percent DDT dust, applied with hand dusters in two of the ex-

periments and with a power duster in another ranged from 41 to 49 percent; a dust containing 0.5 percent of rotenone gave from 96 to 100 percent control. In field experiments at Columbus, Ohio, spray suspensions containing as high as 100 pounds of the 10-percent DDT dust per 100 gallons of water did not control the Mexican bean beetle.--White (373).

Stethorus punctum (Lec.)

Entirely absent from codling moth plots receiving DDT but common on adjacent plots treated with lead arsenate and oil.--Ross (306).

Unidentified Coccinellidae

No coccinelid or chrysopid eggs were observed on the fruit or foliage of a Bartlett pear orchard in the Sacramento River area, California, which has been sprayed with DDT.--Borden and Jeppson (91).

DDT significantly reduced the number of lady beetles on potatoes in western Nebraska.--Tate et al. (342).

A pyrophyllite dust containing 10 percent of DDT reduced the population of ladybirds on alfalfa.--Lieberman (245).

Oryzaephilus surinamensis (L.), the saw-toothed grain beetle

In preliminary tests with DDT in California saw-toothed beetles in stored raisins were controlled.--Baker and Porter (81).

The addition of 50 p.p.m. of DDT to seed wheat (12-percent moisture content) killed all introduced adults at the end of 1 week. The addition of sufficient 3-percent DDT dust to give a concentration of 15 p.p.m. of DDT killed all adults after 2 weeks.--Cotton et al. (120).

Cucujidae

Laemophloeus ferrugineus (Steph.), the rust-red grain beetle

Almicide dust containing 2.6 percent of DDT when mixed with wheat 1:40,000 killed 100 percent of these beetles within 5 days.--Ross (306).

DDT combined with an inert mineral dust and mixed with wheat was completely effective against rust-red grain beetles in mixtures as low as 1 part of the dust in 40,000 parts of wheat.--Smallman (322).

Curculionidae

Anthonomus eugenii Cano, the pepper weevil

In a field experiment at San Clemente, Calif., against the pepper weevil on bell peppers, DDT dusts at 10, 5, and 2.5 percent yielded high-

er mortalities than did a 70-percent cryolite mixture. The mixtures were applied with rotary hand dusters at 7-day intervals, at rates of 15 to 25 pounds per acre. In another experiment in which the 10- and 5-percent strengths of DDT were applied at 14-day intervals the kill of weevils was greater than when the cryolite mixture was applied at 7-day intervals.--White (373).

Anthonomus grandis Boh., the boll weevil

In cage and plot tests DDT dust was not so effective as calcium arsenate. In tests on caged plants the percent mortalities at Tallulah, La., were 75 from 10-percent DDT and 84 from calcium arsenate, and at Waco, Tex., 16 from 10-percent DDT (16 pounds per acre), and 78 from calcium arsenate (8 pounds per acre). In plots at Tallulah five applications of 5-percent DDT dust failed to reduce the weevil infestation below that of the checks. In another experiment the addition of 2.5 percent DDT to calcium arsenate did not increase the effectiveness or produce so much cotton as the calcium arsenate treatment. In other field tests in which DDT in pyrophyllite or mixtures of pyrophyllite and sulfur were used for other insects, the boll weevil infestation was extremely low but was not appreciably reduced by the DDT.--Loftin (247).

Anthonomus signatus Say, the strawberry weevil

Gesarol A-3 dust (3 percent DDT) gave promising results in the prevention of bud cutting by this weevil and appeared to be more effective than a gypsum-cryolite (70-30) dust. The Gesarol was not available in time to apply it before bud cutting was well under way, so its full possibilities were not determined.--Ross (306).

Ceutorhynchus assimilis (Payk.), the cabbage seedpod weevil

In laboratory tests at Sumner, Wash., 10-percent DDT dust showed no toxicity to the cabbage seedpod weevil. A bait spray containing 6 pounds of the 10 percent DDT-pyrophyllite mixture and 45 pounds of sugar in 100 gallons of water was also ineffective.--White (373).

Conotrachelus nenuphar (Hbst.), the plum curculio

DDT appears much less effective than lead arsenate. Tests at Beltsville, Md., with DDT-pyrophyllite (1:1), applied with various fungicides at the rate of 1 1/2 pounds of DDT per 100 gallons, indicated little control of curculio on apple and peach. At Fort Valley, Ga., 4 pounds of DDT (with wetting agent) per 100 gallons seemed to be about equal to the standard 2 pounds of lead arsenate for control of this pest on peach.--Baker and Porter (81).

Gesarol AK-20 at 2 pounds per 100 gallons was inferior to lead arsenate at 3 pounds per 100 gallons in tests in New Hampshire apple orchards during 1944.--Conklin (116).

Ten peach trees were sprayed three times with 2 pounds of 20 percent DDT in 100 gallons of water to control the plum curculio. Owing to the low temperature of March 30 these trees held very little fruit, and comparable records of curculio infestation were not possible. There was no burning of foliage.--Fletcher (155).

DDT, 1 pound per 100 imperial gallons of water, was less effective than 5 pounds of acid lead arsenate, both used with either wettable sulfur or copper oxychloride.--Ross (306).

DDT failed to control curculio.--N. J. Agr. Expt. Sta. (275).

Three applications of a spray containing 2 pounds of A-20 per 100 gallons of water caused no damage to foliage of peaches and no reduction in injury by curculio.--Underhill (349).

Peaches sprayed with 4 pounds of a wettable powder containing 25 percent of DDT yielded 49.6 larvae per 100 drop fruits. In the same experiment identical applications of standard lead arsenate, 2 pounds to 100 gallons, averaged 32.3 larvae per 100 fruits.--Neiswander (274).

Curculio caryae (Horn), the pecan weevil

Curculio rectus (Say), the chestnut weevil

In preliminary tests DDT gave favorable results.--Baker and Porter (81).

Cylas formicarius elegantulus (Summers), the sweetpotato weevil

In laboratory tests at Opelousas, La., DDT was toxic to the sweetpotato weevil but not so toxic as potassium fluosilicate. The 10-percent DDT gave mortalities ranging from 82 to 98 percent, as compared with 98 to 100 percent with undiluted potassium fluosilicate and 80 percent with undiluted calcium arsenate.--White (373).

Cylindrocopturus eatoni Buchanan, the reproduction weevil

A 1-percent DDT emulsion was effective in California.--Craighead and Brown (125).

Listroderes obliquus Klug, the vegetable weevil

In laboratory tests vapo-sprays and a 3-percent DDT dust were applied directly to the larvae or to 1/4-inch carrot sections on which the larvae were later placed. The vapo-sprays containing 1.2 or 2.4 percent of DDT required 3 days to cause 100 percent mortality. The dusts containing 1 percent of DDT killed all weevils in 6 to 9 days.--Lange (242).

Pantomorus godmani (Crotch), the Fuller rose beetle

Same as for Paria canella.--Smith (325).

Pantomorus leucoloma (Boh.), white fringed beetle

When used as a stomach poison, DDT in dust form was 69 to 74 times as toxic as sodium fluoaluminate, and a spray containing 1/8 pound of DDT per 100 gallons of water was about as effective as a spray containing 8 pounds of synthetic cryolite (85.4 percent sodium fluoaluminate). The quantity of DDT applied per acre is the important factor affecting mortality and not the percentage of DDT contained in the dust. As a contact poison dilute sprays containing 1/8 pound or more of DDT per 100 gallons applied directly to beetles produced net mortalities in excess of 60 percent. Adults can accumulate a lethal dose of DDT from contact with surfaces treated with sprays or dusts. Fish oil, when used in a spray, increased the adhesion of DDT on surfaces exposed to outside weathering. The foliage of peanut plants grown in soil containing DDT was not toxic to the beetles. In field-cage tests under different weather conditions a concentrated spray remained effective longer than a dilute spray, and the dilute spray was effective longer than a dust. Applications of 50 and 100 pounds of DDT per acre in the upper 3 inches of soil gave appreciable mortality of beetles caged on the treated soil. No foliage injury was observed on cotton, peanuts, corn, and velvetbeans in field plots that received repeated applications of DDT as a 2.5-percent dust, a dilute spray, and a concentrated spray.--Young (381); also Packard (285).

Pissodes strobi (Peck), the white pine weevil

Preliminary tests indicate that a 1-percent DDT emulsion controls this insect by killing the adult beetles coming to sprayed trees.--Craighead and Brown (125).

Sitophilus granarius (L.), the granary weevil

A complete kill of adults in wheat was obtained at the end of the first week with a 0.05 percent dosage of DDT. A 3 percent DDT-pyrophyllite dust was highly effective after the third week at 15 p.p.m. of DDT.--Cotton et al. (120).

DDT (5 and 10 percent in pyrophyllite) when mixed with grain at the rate of 1 ounce per bushel gave 100 percent control of grain-infesting insects in dry wheat and corn. One-percent DDT at twice this dosage gave 99.5 percent control in wheat and 95.4 percent control in corn. Two hogs were fed corn treated with 10-percent DDT at 1 ounce per bushel. On a basis of 100 pounds body weight, each animal consumed about 283 mg. of

DDT per day. The hogs remained normal in behavior and gained 31.5 pounds of weight each over a 30-day period.--Farrar (150).

The granary weevil, which is the most injurious grain insect, has been almost entirely eliminated from granaries with DDT (applied 1 to 5 times) both in larval or full grown stage.--Ahlberg and Mathlein (69).

A DDT-dust mixed with wheat (1:20,000) was effective against the granary weevil.--Smallman (322).

Almicide dust containing 8.9 percent of DDT when mixed with wheat 1:20,000 killed 100 percent of granary weevils within 9 days.--Ross (306).

Sitophilus oryza (L.), the rice weevil

In a test with seed wheat (12 percent moisture content), 0.05, 0.025, and 0.005 percent by weight of technical DDT was added to 500-gram samples. The samples were put in glass jars with adult weevils. At the end of the first week all three dosages gave a complete kill. In a similar test a 3 percent DDT-pyrophyllite dust was highly effective at 15 p.p.m. of DDT after the first week. Samples of wheat of 14 and 16 percent moisture content were treated with DDT at the rates of 0.05, 0.1, and 0.2 percent by weight. Each sample was artificially infested with 100 adult weevils, and 10 days later all insects were dead.--Cotton et al. (120); also Packard (285).

Gesarol dust (3 percent DDT) when mixed with rice 1-1,000 killed all weevils in 30 hours; at 1-2,000 it killed all in 48 hours; at 1-10,000 the insecticide had practically no effect after 6 hours and 48 hours elapsed before nearly all the weevils acquired a toxic dose; at 1-50,000 practically all weevils were destroyed after 72 hours.--J. (224).

Two lots of seed corn, with 300 rice weevils added to each lot, were treated with a 3-percent DDT dust at 2 ounces per bushel on April 14 and stored in barns at Clemson and at Summerville, S. C. They were insect free on November 14. DDT gave complete protection and germination was not affected. Untreated lots of corn were badly eaten and heavily damaged by the rice weevil, Angoumois grain moths, the cadelle, and other stored grain insects.--Cartwright (108).

Dermestidae

Attagenus piceus (Oliv.), the black carpet beetle

Larvae of this insect were readily killed when confined on a surface deposit of 20 mg. of DDT per square foot, applied as a talc dust. Residues from sprays containing DDT in Deobase or other solvent were less effective, but did give control at higher concentrations of DDT.--Goddin and Swingle (179).

Dermestes lardarius L., larder beetle

In laboratory tests 1 percent of DDT in kerosene gave 100 percent kill within 8 hours by direct contact, and complete, but much slower, kill (after more than 3 days in some cases) when used as a residual poison on filter paper.--Ross (306).

Dermestes vulpinus F., the hide beetle

A spray containing 0.1 percent of DDT in acetone-Deobase (90-10), applied directly on adult beetles, paralyzed them within 1 hour, but all recovered in 6 hours.--Goddin and Swingle (179).

Elateridae

Agriotes lineatus (L.)

Agriotes obscurus (L.)

By watering endive seedlings with a 2-percent suspension of Gesarol (5 percent DDT) at the rate of 100 cc. per plant almost complete protection against wireworms can be achieved.--Geigy Colour Co. (166).

Limonius agonus (Say), the eastern field wireworm

In one plot of an early planting of cabbage seriously damaged by this wireworm, rows were opened and a 1-percent DDT dust was applied in open furrows at the rate of 10 pounds of DDT per acre. The dust was thoroughly mixed with the soil in a band about 6 inches wide, rows were remade, and new plants set. In another plot roots and stems of cabbage plants were dipped in a suspension of 1 pound of 20 percent DDT in 1 gallon of water and transplanted. In other tests DDT added to dichloroethyl ether was applied at the rate of 1/8 gram per plant in comparison with dichloroethyl ether alone. In the first two treatments wireworms were not affected. The treatment affected growth and the plants eventually died. The DDT-dichloroethyl ether treatment was equivalent to the same dosage of dichloroethyl ether alone.--N. J. Agr. Expt. Sta. (275).

Limonius californicus Mann., the sugar-beet wireworm

Limonius canus Lec., the Pacific Coast wireworm

At Walla Walla, Wash., where the sugar-beet wireworm and the Pacific Coast wireworm were used in laboratory tests, the indications are that long periods are required to kill wireworms with DDT and that this material does not act as a repellent. The wireworms killed by DDT appear to be desiccated, as though affected by a strong alkali or exposed to drying, whereas those killed by fumigants are usually stiff and bloated.

In one series of experiments begun in May and repeated in July and August 1944, DDT was thoroughly mixed with the top 9 inches of garden soil and wireworms were caged within the treated soil. The mortalities at the end of 5 weeks' to dosages of 16, 32, 48, and 320 pounds of DDT per acre were 63, 69, 85, and 98 percent, respectively, as compared with 27 percent in untreated soil. The surviving wireworms, many of which were inactive, were placed on moist blotting paper in salve tins and observed for an additional 5 weeks. The mortality at the end of the 10 weeks was 99 percent for the 16-pound dosage and 100 percent for the others.--White (373).

Limonius spp.

Dusts containing 5 or 10 percent of DDT were used at the rate of 1 pound per 100 pounds of potato seed pieces. Treatments were made and potatoes planted on April 19 in experiments on two farms. Wireworm larvae were first noted feeding on the seed pieces on May 7. Treatments had no effect on wireworms and did not affect the growth of the potatoes. --N. J. Agr. Expt. Sta. (275).

Eumolpidae

Glyptoscelis squamulata Crotch, the grape bud beetle

In preliminary tests DDT gave favorable results.--Baker and Porter (81).

Meloidae

Epicauta lemniscata (F.), three-lined blister beetle

Macrobasis fabricii (Lec.), the ash-gray blister beetle

Tests with a 3-percent DDT dust gave complete control in 18 hours. --Okla. Agr. Expt. Sta. (278); Hamilton (200).

Epicauta spp., blister beetle

A 3-percent DDT dust was effective in Missouri.--Haseman (203).

A knapsack sprayer was used in making 5 applications of 20-percent DDT spray on early potatoes and 3 applications on late potatoes. Blister beetles were not serious.--Gould (184).

Ostomidae

Tenebroides mauritanicus (L.), the cadelle

In the first test as described under Sitophilus oryza, at the end of 5 weeks, 20, 48, and 76 percent of the larvae were still alive in the

jars treated with the 0.05, 0.025, and 0.005 percent of DDT. In the second test a 3-percent DDT dust killed all the larvae after the fifth week at 30 p.p.m. of DDT. The use of a DDT-oil spray may be the best means yet discovered for destroying infestations persisting in woodwork. In a third test, the interior walls of some bins were sprayed with a refined odorless kerosene containing 6 percent of DDT. A few days later the floors of the bins were littered with large numbers of dead adults and larvae. In one bin 8,000 dead cadelles were swept from the floor at the base of 10 feet of sprayed wall, and the killing action persisted for some time.--Cotton et al. (120).

See Sitophilus oryza.--Cartwright (108).

Scarabaeidae

Autoserica castanea (Arrow), the Asiatic garden beetle

A single spray of 1 pound of DDT in 100 gallons of water plus ¼ pound of Areskap was applied to chrysanthemum plants with a knapsack sprayer. The day after spraying, 60 beetles were caged over the treated plants. After 2 days a 91 percent kill of beetles resulted. No further injury occurred on the sprayed plants.--N. J. Agr. Expt. Sta. (275).

When DDT was applied at rates of 20, 30, and 50 pounds per acre to infested soil in a nursery the 20-pound-per-acre treatment caused a reduction of 99 percent and the heavier dosages 100 percent in larval population.--Hadley and Fleming (196).

In preliminary tests DDT gave favorable results in the control of the grubs.--Baker and Porter (81).

Cyclocephala borealis Arrow, an annual white grub

Same as for Autoserica castanea.--Baker and Porter (81).

Macrodactylus subspinosus (F.), the rose chafer

Grape foliage and clusters were sprayed with DDT (1.5 pounds in benzene-kerosene emulsion per 100 gallons of water) on June 5, and 25 beetles were put in each of 2 cages on June 5, 8, 13, and 17. All the beetles were knocked down in less than 24 hours and were dead in less than 48 hours.--Baker and Porter (81).

In the insectary 3-percent DDT dust gave 100 percent control within 18 hours of beetles placed on dusted foliage up to 4 days after treatment. In field tests dusted roses remained free of beetle attack but untreated blossoms were destroyed.--Ross (306).

A spray of 1 pound of DDT in 100 gallons of water, together with a conditioner, gives excellent protection against the rose chafer. A 10-percent DDT dust controls the rose chafer.--Hutson (220).

Phyllophaga spp., white grubs

In a few preliminary tests Gesapon No. 18, at a dilution of approximately 8 ounces of DDT per 100 imperial gallons of water had no apparent effect on eggs, and little or none on second-instar grubs when the emulsion was either poured or injected into the soil.--Ross (306).

In a single test at Lafayette, Ind., a dust containing 5 percent of DDT applied to the soil in a cage at the rate equivalent to 242 pounds of DDT per acre and washed in with a copious sprinkling of water had no effect on the white grubs that had been placed in the soil. Young corn plants about 8 inches tall were visibly affected. This was a very preliminary experiment, however, and cannot be considered conclusive.--Packard (285).

Popillia japonica Newm., the Japanese beetle

Preliminary tests with DDT in 1943 indicated that this material was the best protective agent ever used against the adults and that it appeared very toxic to the larvae in the soil. The tests were continued in 1944 on a much larger scale. Laboratory tests indicated that the duration of effectiveness of DDT may be reduced when it is used with bordeaux mixture, wettable sulfur, lime-sulfur, or tank-mix copper phosphate, but Fermate did not seem to modify its effectiveness. In field tests one application of a spray containing DDT 1 lb., pyrophyllite 1 lb. (micronized together), fish glue solution 1 pt. (1 lb. of liquid glue per gallon); summer oil emulsion 1 quart, and water to make 100 gallons at the rate of 1 pound per 100 gallons, at or just prior to the beginning of the beetle season, gave satisfactory protection to the fruit and foliage of early ripening peaches and apples, blueberries, and miscellaneous ornamental and shade trees and shrubs. As many as three applications were necessary to give satisfactory control on grapes on account of the development of new growth during the beetle season. Flowering plants and ornamentals producing blooms and new growth while the beetles are flying also required up to three applications. In other field tests, turf and nursery plots were treated with DDT applied as a spray or dust. When applied as a spray, the 50-percent micronized DDT-pyrophyllite mixture was used at 2 pounds to 100 gallons of water. The best dust mixture consisted of DDT 10, pyrophyllite 10 (micronized together), talc 78, and tricalcium phosphate 2 percent. The results indicate that this material is more toxic than lead arsenate and that a dosage of 25 pounds per acre, applied either as a dust or as a spray, will practically eliminate the larval population.--Hadley and Fleming (196).

Effective control of Japanese beetles attacking silking corn ear tips was obtained with dusts containing 4 percent of DDT or 4 percent of a DDT byproduct (primarily a mixture of dichlorodiphenyltrichloroethane, dichlorodiphenyldichloroethane, and the o,p-isomer of DDT). The counts, in beetles per ear, were 0.11 and 0.04, respectively, for the treatments, and 6.10 for the control. Corn dusted with these materials contained 1.0 and 1.2 European corn borers per stalk, with 2.8 as the average for the control. In another test the 4 percent DDT dust and a spray containing 0.8 pound of DDT per 100 gallons reduced the average borer population to 0.6 and 0.8, per stalk as compared with 2.6 in the control.--Wolfenbarger et al. (379).

"DDT is promising. It is a very effective soil poison. We can get as good initial control of this beetle in the soil with 15 pounds of this material per acre as with 500 pounds of lead arsenate per acre. Probably the most important development in respect to the Japanese beetle has been the use of DDT, which has proven very effective on the larvae in the soil and apparently is more toxic than any other material. We have obtained very excellent control of the adults by using one-sixteenth of a pound to 100 gallons of water. With one application of stronger concentrations we have been able to get protection on peaches from these beetles for the full season. The result this year with DDT alone is the most promising thing we have obtained yet, but the results on control with milky disease are very good."--Annand (74).

In laboratory tests as little as 1/16 pound of DDT in 100 gallons of water was as efficient as 6 pounds of lead arsenate. In combination with most fungicides it was slightly less effective. In field tests one to three sprays of DDT (micronized with equal parts of pyrophyllite, and with glue as a wetting agent), applied at the rate of 1 pound per 100 gallons, gave almost complete control of the beetles on peaches, early apples, grapes, blueberries, ornamental and shade trees, and shrubs. Applications after the first spray were necessary largely to protect new growth. DDT applied in spray or in dust form was also very effective in soil treatments against the grubs. In tests with 28 different soils 25 pounds of DDT per acre was more effective against third-instar larvae than 1,000 pounds of lead arsenate, and the effectiveness of the DDT in the soil was not changed during the period of the tests.--Baker and Porter (81).

A DDT aerosol gave excellent kills.--Ditman (133).

Three sprays of DDT (same treatment as for grape leafhopper) gave very good control of Japanese beetle on grapes.--N. J. Agr. Expt. Sta. (275).

After an application of a DDT spray to sweet grapes (New York Muscats) wasps, bees, and Japanese beetles disappeared.--Bromley (96).

DDT was applied as dusts (3 and 5 percent) and as a spray (4 pounds of a wettable powder containing 25 percent of DDT per 100 gallons) on grapes. Fewer specimens were found on the treated plants than on untreated plants but no dead beetles were found beneath or near the treated plants. Smaller leaf areas were consumed on the plants treated with DDT than with any of the other materials tested.--Polivka (294).

Scolytidae

Dendroctonus engelmanni Hopk., the Engelmann spruce beetle

Preliminary results indicate that these beetles were prevented from attacking green logs in the laboratory by the application of DDT in an oil emulsion, and finally all were killed.--Craighead and Brown (125).

Scolytus multistriatus (Marsham), the smaller European elm bark beetle

In extensive experiments conducted at Morristown, N. J., solutions and emulsions containing 2 to 5 percent of DDT prevented crotch feeding in living elm trees by adult beetles for more than 110 days. Lower concentrations of DDT were effective for shorter periods. Similar sprays containing as little as 0.25 percent of DDT prevented beetles from entering the bark of sprayed logs for over 69 days, and sprays containing 2 percent of DDT gave protection for more than 160 days. An emulsion containing 0.5 percent of DDT, when applied to elm wood infested with larval broods, permitted some emergence of adults, but affected the emerging beetles to the extent that none were able to attack suitable material caged with them. Solutions of as little as 0.25 percent of DDT, when applied to similar infested material, prevented all emergence.--Craighead and Brown (125).

Scolytus rugulosus (Ratz.), the shot-hole borer

In California three almond trees were treated with a DDT spray but the effect on the borers was not determined.--Swanson and Michelbacher (340).

Ambrosia beetles

Bark beetles

See under Cerambycidae.--Craighead and Brown (125).

Tenebrionidae

Blapstinus auripilis Horn, a darkling beetle

In a cage test 100 percent kill of this insect was obtained in 67 hours with 2 percent DDT.--Loftin (247).

Tribolium castaneum (Hbst.), the red flour beetle

Same as the first test of Sitophilus oryza.--Cotton et al. (120).

Tribolium confusum Duv., the confused flour beetle

Same as the first and second tests of Sitophilus oryza. In a third test, garden seeds in paper envelopes were treated with 0.05 percent of DDT, repackaged, and placed with untreated lots in a special cabinet. After 2 months the treated seeds were undamaged while the untreated seeds were heavily infested. In a fourth test, spraying with odorless kerosene containing 5 percent of DDT cleaned up an infestation in a wallboard partition of a flour-storage room. In a fifth test, kraft bags were treated in three ways--by dipping in a 10-percent solution of DDT in acetone, by painting one side with varnish containing 10 percent of DDT, and by coating one side with a clay coating liquor containing 10 percent of DDT. The bags were filled with flour, tightly sealed and exposed to a heavy infestation of flour beetles. All the treated bags resisted penetration by these insects for many months, whereas bags made of untreated kraft paper were usually penetrated within a few days. In a sixth test, ordinary cotton flour bags and No. 5 kraft paper bags were treated with 5 percent of DDT in carbon tetrachloride. Considerable resistance to beetle attack was imparted to both types of bags by impregnation with DDT.--Cotton et al. (120).

A DDT dust mixed with wheat 1 to 15,000 was effective.--Smallman (322).

Within 5 minutes after 100 adults in a box about 18 inches square were sprayed with a 5-percent DDT solution all were dead or incapacitated. Another 100 adults put in the same sprayed box 24 hours later were soon killed by the residue. In a similar box sprayed and allowed to stand for 30 days before 100 beetles were introduced, 24 hours were required before the insects succumbed. In other tests the beetles were killed only in the adult stage and DDT was not effective against the eggs, larvae, and pupae.--Davis (129, 130).

Almicide dust containing 18 percent of DDT when mixed with wheat 1:15,000 killed 90 percent of confused flour beetles within 10 days.--Ross (306).

Miscellaneous Coleoptera

Examination of the ground under hairy vetch at Oregon City, Oreg., disclosed that 5-percent DDT dust had killed insects of several species, including many beetles (nitidulids, carabids, silphids, elaterids, coccinellids, and Diabrotica 11-punctata Mann.), flea beetles, weevils (Sitona sp. and Brachyrhinus sp.), and pea weevils. Coccinellid larvae, which were abundant, appeared to be unaffected. Some of these insects,

especially coccinellid beetles, were also found dead on the rotenone dust and bait-spray plots. There were no ill effects on the operators, who found DDT to be much less irritating than the rotenone dust.--Rockwood and Reecher (303).

NEUROPTERA

Chrysopidae

No chrysopid eggs were observed on the fruit or foliage of a Bartlett pear orchard in the Sacramento River area, California, which had been sprayed with DDT.--Borden and Jeppson (91).

LEPIDOPTERA

Aegeriidae

Bembecia marginata (Harr.), the raspberry root borer

The following materials were applied one, two, and three times to separate plots: A spray of 5 pounds of DDT in pyrophyllite (20-80) plus 1/2 pound of soybean flour in 100 gallons; a 3-percent DDT dust applied with an ordinary hand crank duster at the rate of 40 pounds to the acre; and a DDT-dichloroethyl ether emulsion which contained 1 pound of DDT to 100 gallons. Only the DDT-pyrophyllite spray treatment gave any marked reduction of borers over the check and the single spray was nearly as good as two and three applications. In 1943 tests the emulsion treatment gave a marked reduction over the check.--N. J. Agr. Expt. Sta. (275).

Melittia satyriniformis Hbn., the squash borer

This insect was controlled with Gesarol A-3 dust as described for Anasa tristis.--Parker (287).

A 3-percent DDT dust and a spray containing 1 pound of actual DDT in 100 gallons of water gave control comparable to a 1-percent rotenone dust on squash borer.--N. J. Agr. Expt. Sta. (275).

In plots treated with 3-percent DDT dust 86 percent of the plants were uninfested as compared with 58 percent for plots treated with 35 percent cryolite and 20 percent for untreated plots.--Tate et al. (342).

Synanthedon pictipes (G. and R.), lesser peach borer

A solution of 150 grams of DDT in 500 cc. of ethylene dichloride was emulsified with an equal part of water and painted on infested cankers on peach trees in May. Results taken in November showed an average of 4 feeding borers in each treated canker and 5.5 in each check. --Ross (306).

Arctiidae

Hyphantria cunea (Drury), the fall webworm

This insect was readily controlled with emulsions containing 0.1 to 1 percent of DDT.--Craighead and Brown (125).

Fall webworm nests were destroyed by a 3-percent DDT dust, all the larvae dropping out and falling to the ground within 24 hours.--Fluke and Pond (157).

Citheroniidae

Anisota rubicunda (F.), the green-striped maple worm

In a Vermont maple-sugar orchard an aerial application of DDT (5 pounds of DDT in 5 gallons of solvent per acre) used against the gypsy moth gave complete control of this maple worm.--Craighead and Brown (125).

In treatments applied from an airplane against the green-striped maple worm, the spray was mixed at the rate of DDT 1 pound, cyclohexanone 1 pint, and a horticultural spray base heavy oil about 7 pints (enough to equal 1 gallon of mixed spray).--Dowden et al. (136).

Coleophoridae

Coleophora malivorella Riley, the pistol casebearer

In preliminary tests with DDT favorable results were obtained in the control of this insect on apple.--Baker and Porter (81).

Crambidae

Crambus topiarius Zeller, the cranberry girdler

DDT was applied to cranberries in New Jersey as a dust before bloom and as a spray to wet the chaff after bloom. It appeared that between 2,500 and 5,000 gallons of water per acre might be needed to spray the chaff with any degree of effectiveness. The length of girdler wounds, as percentage of total length of chaff-covered stems, was 5.8 in an untreated bog, 5.2 and 1.6 in areas treated with sprays containing 12½ and 25 pounds of DDT per acre, and 2.4 in an area dusted with 50 pounds of DDT per acre.--Doehlert (134).

Diatraea saccharalis (F.), the sugarcane borer

A pyrophyllite dust containing 10 percent of DDT, applied four times at weekly intervals at the rate of about 8 pounds per acre-application,

was inferior to cryolite against both first- and second-generation borers. A DDT spray (20 pounds of 10 percent DDT-pyrophyllite plus 7 1/2 ounces of a sticker per 100 gallons) applied at the rate of 50 gallons per acre four times at weekly intervals gave 29 percent control as compared with 85 percent when synthetic cryolite dust was used. The increase in borers in the DDT plots in the first experiment may have been due to its effect on Trichogramma and other natural enemies of the borer under conditions of a heavy infestation, when Trichogramma is usually more abundant.--Ingram et al. (222).

DDT is not effective.--Annand (74).

Gelechiidae

Anarsia lineatella Zell., the peach twig borer

One application of Gesarol A-20, at the rate of 2 pounds per 100 gallons of water, to an apricot tree when the apricots were 1/2 inch in diameter resulted in a crop of wormfree fruit.--Jones (232).

Gnorimoschema operculella (Zell.), the potato tuber worm

In laboratory tests larvae displayed a violent reaction to DDT materials applied directly to them. They reacted faster to vapo-sprays than to 3-percent DDT dust. Adult moths dusted or sprayed with the DDT combinations immediately lost power of locomotion, and died within 24 hours.--Lange (242).

Thoroughly dusting seed potatoes with a 2-percent DDT dust prevented them from becoming infested with newly hatched tuber worms.--Walker (365, 366).

Keiferia lycopersicella (Busck), the tomato pinworm

DDT dust (5 percent) and spray (4 pounds of a 25-percent wettable powder per 100 gallons) were more effective than cryolite dust or rotenone spray.--Neiswander (274).

Pectinophora gossypiella (Saund.), the pink bollworm

DDT is the most effective material yet found against this pest but it causes an increase of aphids. In preliminary tests a combination of DDT with an arsenical was very good.--Annand (74).

DDT is the most promising material that has been tested against this insect. At Presidio, Tex., DDT, cryolite, and mixtures of the two were compared on 1/5-acre plots. Dust applications of approximately 15 pounds per acre were started when the oldest bolls were large enough for the pink bollworm to attack, and were repeated at approximately 5-day intervals.

The reduction in the larval population in the bolls after eight applications was 53 from 2.5-percent DDT, 78 from 5-percent DDT, 88 from 10-percent DDT, 62 from DDT-pyrophyllite-cryolite (2.5:22.5:75), 61 from DDT-pyrophyllite-cryolite (5:45:50), and 44 from cryolite alone. In tests at Brownsville, where moths were caged on plants heavily dusted with DDT, no larvae developed in the bolls. In similar tests with smaller dosages of 5, 10, and 20 percent DDT applied at the rates of 5/8 to 3 pounds of the mixture per acre, the reduction in larvae ranged from 25 to 81 percent. Small larvae crawling over a dust film of 10-percent DDT were extremely irritated but not killed, indicating that the reduction in population might have been due to killing the moths before oviposition occurred.--Loftin (247).

Sitotroga cerealella (Oliv.), the Angoumois grain moth

Same as for Sitophilus oryza.--Cartwright (108).

Geometridae

Alsophila pometaria (Harr.), the fall cankerworm

Small-scale experiments in which newly emerged moths were placed in cages the insides of which had been dusted with Gesarol A-3 dust (3 percent DDT), showed that high mortality, in many cases 100 percent, resulted after an exposure period of 8 to 24 hours. In a number of the tests no eggs were laid; in others approximately 1 to 6 per female were deposited as compared with approximately 60 per female in untreated checks.--Ross (306).

In small-scale tests this pest was readily controlled with DDT in concentrations of 0.1 to 1 percent applied as an emulsion.--Craighead and Brown (125).

Bupalus piniarius (L.)

Gesarol has been applied from an airplane to control this insect in forests in Sweden.--Geete (165); Anon. (59).

Glyphipterygidae

Homadaula albizziae Clarke, the mimosa webworm

This webworm was readily controlled with 0.1 to 1 percent of DDT applied as an emulsion in small-scale tests.--Craighead and Brown (125).

Hyponomeutidae

Plutella maculipennis (Curt.), the diamondback moth

As a stomach poison 2 ounces of DDT per 100 imperial gallons of water for all formulas tested gave kills approaching 100 percent. The

contact action of DDT in acetone suspension or Velsicol emulsion was much greater than in powder suspensions.--Ross (306).

See Pieris rapae.--Granovsky (187).

See Trichoplusia ni.--N. J. Agr. Expt. Sta. (275); White (373).

Lasiocampidae

Malacosoma americana (F.), the eastern tent caterpillar

This caterpillar was effectively controlled with a very small amount of DDT spray (such as 0.1 percent) applied as an emulsion to the egg bands or later to the foliage or tents.--Craighead and Brown (125).

In laboratory tests DDT in acetone suspension with Tergitol Penetrant 7 at the rate of 1 pound per 100 imperial gallons of water was toxic to large caterpillars and caused almost immediate cessation of feeding.--Ross (306).

Lymantriidae

Hemerocampa vetusta (Bdv.), the western tussock moth

Infested Bartlett pear trees were sprayed with 2.5 quarts of 20-percent DDT per 100 gallons of water. The control obtained was good, but the spray caused a spotted leaf injury.--Borden and Jeppson (94).

Apple trees infested with immature larvae were treated with DDT, with the same results as described for Archips argyrospila.--Borden and Jeppson (90).

Porthetria dispar (L.), the gypsy moth

Experiments in the aerial application of DDT were conducted at Greenfield, Mass., during 1944. Complete control was obtained in a 20-acre oak woodland with 5 pounds of DDT in 5 gallons of solvent per acre, applied before the eggs had hatched and before the foliage appeared. Later tests with the same dosage killed all the second- and third-stage larvae in a 5-acre woodland plot. The spray formula consisted of 1 part by weight of DDT, 1 part of cyclohexanone, and 7 parts of a light oil. A similar formula was used in nearly all subsequent tests, except that from 1.5 to 1.8 parts of xylene was substituted for 1 part of cyclohexanone. The spray settled through the forest canopy to the understory as a fine mist, leaving upon evaporation a uniform crystalline deposit of DDT on all parts of the trees. At New Haven, Conn., as little as 1/2 pound of DDT per acre gave good control of last instars of the gypsy moth on small plots of low-growing trees.--Craighead and Brown (125); Dowden et al. (136).

Complete control of the gypsy moth with spray applied just before hatching of the eggs and after larvae were partly grown was obtained by using 5 pounds of DDT in 5 gallons of oil per acre.--Dowden et al. (136).

Notodontidae

Datana integerrima G. and R., the walnut caterpillar

An application of Gesarol A-3 dust to a heavily infested pecan tree resulted in a complete clean-up 2 days later.--Janes (225).

Olethreutidae

Ancylis comptana fragariae (Walsh and Riley), the strawberry leaf roller

DDT gave better control of this insect than three applications of 40-percent nicotine sulfate spray, the standard recommended insecticide treatment.--Parker (287).

This was one of the most resistant lepidopterous larvae tested. In greenhouse tests DDT 16 ounces (powder suspension) per 100 imperial gallons of water gave less than 70 percent kill as a stomach poison, DDT 32 ounces (powder suspension) as a contact spray killed 15 percent, and DDT 16 ounces in Velsicol emulsion killed 45 percent by contact. In field tests poor results were obtained with a dust containing 3 percent of DDT, 0.3 percent of Orvus, and 26.7 percent of talc in pyrophyllite, and with a spray of DDT 8 ounces in powder suspension. Four days after treatment the mortality was 36 percent for the dust, 15 percent for the spray, and 8.9 percent for the check.--Ross (306).

Carpocapsa pomonella (L.), the codling moth

In orchard tests DDT at 1 pound per 100 gallons was more effective than 3 pounds of lead arsenate. The proportion of stings was greatly reduced. Eggs sprayed with DDT developed normally and hatching was only slightly below normal. Some of the young larvae were killed, but it was concluded that DDT alone could not be regarded as an ovicide. Codling moths in cages sprayed with DDT were killed, but not so quickly as when nicotine is used. To test the residual effect of DDT on the moths, cages were sprayed and the insects were put in them later. Residue 2 to 4 days old was very effective, 12 to 18 days old moderately effective, and 26 to 28 days old only slightly effective. To kill the moths it was necessary to leave them in the sprayed cages 5 hours or longer. In laboratory tests young larvae were affected by DDT residue after crawling 15 to 30 minutes over the sprayed fruit.--Hough (217, 218).

In work with the codling moth on walnuts at Linden, Calif., the effects of one and two applications of sprays containing 5 pounds of 20-

percent DDT wettable powder (A-20) in 100 gallons of water were compared. One application on May 9, when the walnuts were still extremely small, gave exceptionally good control. Trees sprayed May 9 and again on June 26 gave as perfect control as could be expected. Although the results are very promising, much more work is needed before DDT can be safely recommended for commercial use.--Michelbacher et al. (259).

Used at the rate of approximately 13 ounces in 100 gallons of water, DDT gave as good control of codling moth in a McIntosh apple orchard in western New York as 3 pounds of lead arsenate in 100 gallons, the standard spray mixture. The addition of oil to the DDT spray increased its effectiveness considerably. A 3-percent DDT dust gave some protection, but it was not nearly so effective as the spray.--Anon. (17).

In a large commercial Bartlett pear orchard in the Sacramento River [Calif.] area 8 large trees were selected for the DDT experiment. When the investigation was started, 2 lead arsenate sprays had already been applied. The composition of the spray for one series was 2 1/2 quarts of 20 percent DDT in oil with emulsifier per 100 gallons of water; for a second series, 5 pounds of 20-percent DDT wettable powder (A-20) per 100 gallons of water. The trees in each series received 2 to 4 applications. No codling moth injury was noted at any time. The DDT suspension spray caused no discernible injury and gave excellent coverage. The 20-percent DDT in oil showed poor wetting, and spotted-leaf injury occurred. Red spider injury appeared earlier and was more severe in the DDT plots than it was in the remainder of the orchard receiving the regular lead arsenate and dinitro treatments. Analyses showed a higher deposit of DDT remaining on the fruit at harvest when the DDT was combined with oil than when DDT was applied in water-suspension form. All DDT deposits were below 7 p.p.m.--Borden and Jeppson (91).

Results of small-scale orchard experiments at several laboratories indicated that DDT (0.5 to 1 pound per 100 gallons of spray mixture) is equal or superior to lead arsenate, cryolite, or nicotine bentonite. At Vincennes, Ind., 4 ounces of DDT with half the usual concentration of lead arsenate or nicotine bentonite reduced the number of wormy apples to less than half of that resulting from standard lead arsenate or nicotine bentonite alone and as good results as DDT, 1 pound per 100 gallons, without any other insecticide. At Kearneysville, W. Va., four applications of DDT, 1 pound per 100 gallons, gave almost perfect control of first-brood worms. At Yakima, Wash., (6 cover sprays), 3 pounds of lead arsenate gave 16.6 worms per 100 apples, whereas 1/2 pound of DDT plus 1 pound of pyrophyllite gave only 11.4 worms per 100 apples. At Poughkeepsie, N. Y., a 5-percent DDT dust was more effective than a 20-percent lead arsenate dust or 20-percent lead arsenate dusts combined with oil. Both here and at Vincennes DDT dusts were not so efficient as the sprays.--Baker and Porter (81).

Four midseason applications of emulsive summer oil containing DDT (about 2 ounces per 100 gallons) with no sprays after July 17, gave good control. Jonathan apples in this heavily infested, poorly cared for

orchard showed 50.40 percent codling moth injury at harvest. An imperfectly sprayed lead arsenate check plot showed 66.47 percent injury. On Hubbardson, the DDT-oil plot had 48.63 percent, and the lead arsenate check plot 56.62 percent codling moth injury. In a well-sprayed and well-cared for Delicious orchard, four mid-season applications of the DDT-oil, followed by an oil-nicotine schedule, produced fruit showing 2 percent codling moth injury; the standard lead arsenate schedule, followed by oil-nicotine schedule, produced fruit showing 3.3 percent injury.--Cleveland (114).

DDT at 1 or 2 pounds per 100 gallons of water proved to be the most outstanding of all materials used to control codling moth at Hood River, Oreg. Moths are not particularly affected by the spray; also the spray failed to prevent hatching.--Childs and Robinson (111).

In laboratory tests most newly hatched larvae were killed by 2 to 4 ounces of DDT per 100 imperial gallons of water applied as a suspension. DDT in other forms was less effective, although much more effective than lead arsenate. Mature larvae were very resistant to the contact action of DDT. DDT tested against adults at 5 pounds per 100 gallons was slightly less effective than sodium dinitro-cresylate.--Ross (306).

When used on a block of apple trees, DDT gave sensationally good control of the apple worms but killed off the small parasitic wasps, introduced 10 years ago to check the woolly aphids; freed of their natural enemies, the aphids increased immediately to dangerous numbers.--Burtner (98).

DDT used on the same schedule as lead arsenate, at the rate of 1 pound of DDT to 100 gallons of spray, gave much better control of the codling moth. All experiments seemed to indicate that for excellent control, lead arsenate should be used early in the season and DDT later. --Hutson (220).

In a large-scale test at Vincennes, Ind., DDT was more effective than one of the best nicotine bentonite programs available, where the ratio of DDT to nicotine sulfate (40 percent) was approximately 1 pound per pint. At 1 pound per 100 gallons in small field-plot tests DDT gave much better control than the standard lead arsenate program (4 and 3 pounds per 100 gallons). DDT is a very effective supplement or fortifying agent when added in small quantities to lead arsenate or nicotine bentonite and can be used in split schedules ahead of or following sprays of lead arsenate, or nicotine bentonite. It can be used effectively with summer oils and with bordeaux mixture.--Steiner et al. (334).

The effectiveness of some compounds closely related to DDT and of their dehydrohalogenated derivatives against codling moth larvae when tested by the apple-plug method was determined. Each compound was used

at the rate of 4 pounds to 100 gallons of carrier (20 percent ethanol).

Compound	Formula	Percent of Apple Plugs	
		Wormy	Stung
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane (DDT)	$(C_6H_4Cl)_2CHCCl_3$	0	0
2,2-Bis(p-bromophenyl)-1,1,1-trichloroethane	$(C_6H_4Br)_2CHCCl_3$	23	17
2,2-Di-p-anisyl-1,1,1-trichloroethane	$(C_6H_4OCH_3)_2CHCCl_3$	3	0
2,2-Di-p-tolyl-1,1,1-trichloroethane	$(C_6H_4CH_3)_2CHCCl_3$	7	2
2,2-Bis(p-acetoxyphenyl)-1,1,1-trichloroethane	$(CH_3COOC_6H_4)_2CHCCl_3$	99	0
2,2-Diphenyl-1,1,1-trichloroethane	$(C_6H_5)_2CHCCl_3$	47	0
2,2-Bis(p-chlorophenyl)-1,1-dichloroethylene	$(C_6H_4Cl)_2C:CCl_2$	85	0
2,2-Bis(p-bromophenyl)-1,1-dichloroethylene	$(C_6H_4Br)_2C:CCl_2$	86	4
Lead arsenate		40	7
Check (no treatment)		95	0

Siegler and Gertler (316).

Grapholitha molesta (Busck), the oriental fruit moth

Injury to peaches was reduced considerably in field plots sprayed with DDT, 1 pound per 100 gallons. Two applications, one each just before the appearance of second- and third-brood larvae, were more effective than one application made prior to appearance of the second brood. The DDT sprays reduced the activity of the parasite Macrocentrus ancylivorus Roh., but did not eliminate it. At Moorestown, N. J., DDT sprays were much more toxic to the adults of the parasite than of the fruit moth, and the residues were toxic to them for a much longer period.--Baker and Porter (21).

One pound of DDT (Gesarol AK-20) per 100 imperial gallons of water was 87 percent efficient against a very light infestation.--Ross (306).

Two sprays of 1/2 pound of DDT in 100 gallons plus a sulfur fungicide brought about 85 percent reduction of oriental fruit moths in blocks of Elberta and Hale Haven peaches.--Hutson (220).

Polychrosis viteana (Clem.), the grape berry moth

In small-scale tests at Sandusky, Ohio, 1.5 pounds of DDT (emulsified with benzene-kerosene) per 100 gallons did not kill the eggs on grape berries, but was about 50 percent effective 20 days after application against larvae trying to enter the berries. In one field test this treatment was more effective when used in three or four applications than lead arsenate in four applications, but in another field test, one application of DDT did not hold up so well as one application of lead arsenate. In a field test with DDT, 1 pound per 100 gallons, on Niagara grapes in New Jersey, 15.6 percent of the berries were injured in the DDT plot, and 41.7 percent in the lead arsenate plot, but on Jersey Muscat grapes DDT was no more effective than the standard lead arsenate treatment.--Baker and Porter (81).

A DDT spray used against Popillia japonica gave fair control of this moth.--Hadley and Fleming (196).

The efficiency of three spray schedules as compared with an unsprayed check (efficiency zero) was as follows: Three sprays of lead arsenate and nicotine sulfate 75 percent, three sprays of lead arsenate and summer oil 81 percent, and one spray of lead arsenate with nicotine sulfate followed by two sprays of DDT, 1 pound per 100 imperial gallons, 73 percent.--Ross (306).

The grape berry moth was controlled by three sprays of DDT, 1 pound per 100 gallons.--Hutson (220).

Laspeyresia caryana (Fitch), the hickory shuckworm

In preliminary tests DDT gave favorable results.--Baker and Porter (81).

Melissopus latiferreanus (Wlsm.), the filbert worm

In July DDT, Gesarol A-3 dust and A-20, 2 pounds in 100 gallons of spray, was applied with power machines to 70 to 96 trees in three filbert orchards in the Willamette Valley at the rate of 65 pounds per acre--10 to 12 gallons per tree. Results were favorable, but slightly less effective than with lead arsenate. Infestation in nuts was slightly more in the DDT-treated orchards than in the lead arsenate check.--Thompson (346).

Spilonota ocellana (D. and S.), eye-spotted budmoth

In Nova Scotia one summer application of DDT 1 pound (powder suspension) per 100 imperial gallons of water gave much poorer control than Black Leaf 155 and appeared to be no better than lead arsenate. At Simcoe, Ontario, a similar spray reduced the injury from 38.4 percent in the check to 24.0 percent when only the undersides of the leaves were covered, and to 21.8 percent where both surfaces were sprayed.--Ross (306).

Phalaenidae

Ceramica picta (Harr.), zebra caterpillar

Gesarol A-3 dust (3 percent DDT) applied to one-third to one-half grown caterpillars on cabbage plants caused all larvae to leave the plants and killed at least part of them within 22 hours, both when the dust was applied to the larvae on the leaves and to the leaves only. Dusting with talc alone caused very few larvae to leave.--Ross (306).

Feltia subterranea (F.), the granulate cutworm

See Diaphania nitidalis.--Cartwright (108).

Alabama argillacea (Hbn.), the cotton leafworm

DDT was of no practical value for control. At the Waco, Tex., laboratory, the median lethal dosage of a DDT suspension applied to the dorsa of fifth-instar leafworms was 61.5 mg. per gram of body weight, or 206 times as great as that for the bollworm. In field tests 3 or more applications of approximately 16 pounds per acre of 1, 2, 4, and 8 percent DDT dust applied with hand dusters at Waco, and 4 percent DDT dust applied by airplanes at Bryan, Tex., failed to prevent defoliation of plants. Field plots at Tallulah, La., were defoliated following 5 applications of 5-percent DDT dust. At Presidio, Tex., where 8 to 10 heavy dust applications were made for the pink bollworm, DDT gave considerable control of the leafworm. At Waco cotton plants sprayed six times with DDT suspension at the rate of 0.64 pound of DDT per acre-application caused a greater reduction of leafworms than plants dusted with the same dosage, but neither treatment prevented almost complete defoliation.--Loftin (247).

DDT is not so effective as the arsenicals. We may be able to overcome the leafworm with a combination of DDT with an arsenical.--Annand (74).

Autographa sp., a looper

There was some indication that DDT in oil applied as a vapo-spray was effective at high concentrations.--Lange (241).

Anagrapha falcifera (Kirby), the celery looper

This insect was completely controlled with one application of DDT, and reinfestation did not occur for 5 weeks.--Russell (308).

Caenurgina sp.

Examination of the ground under hairy vetch at Oregon City, Oreg., disclosed that a 5-percent DDT dust had killed insects of this species. --Rockwood and Reeher (303).

Heliothis armigera (Hbn.), the corn earworm, the tomato fruitworm, the bollworm

DDT was the only insecticide which protected the corn until harvest-time. DDT in mineral oil gave almost complete control of the corn earworm in both the green and the maturing stages of the corn ears. Pyrethrum, styrene dibromide, and dichloroethyl ether were all less effective. Two highly refined mineral oils were used, Bayol (80-90 sec. Saybolt) and Superla No. 13 (120-125 sec. Saybolt). Each insecticide was tested in both oils, in the following concentrations: DDT 2, pyrethrum extract (0.2 percent pyrethrins), dichloroethyl ether 2, and styrene dibromide 1 percent. They were applied at two dosages, 0.6 and 1.2 ml. of solution per ear.--Blanchard and Satterthwait (88).

When silks of sweet corn were dusted heavily with Gesarol A-3, the reductions in wormy ears were 50, 40, and 30 percent in three tests.-- Ewart (145).

In testing six methods of ear treatment the DDT-dusted plot had 3.56 of percent infested ears as against 7.26 percent in the check and only 0.99 percent in the oil treatment.--Granovsky (187).

A 3-percent DDT dust applied to the silks was effective.--Haseman (203).

Three applications of Gesarol A-3 dust to cotton showed only 8.3 percent repellency against ovipositing moths.--Fletcher and Thomas (156).

Dusting the silks of sweet corn with a 3 percent DDT dust materially reduced earworm infestation. Of 59 treated ears 32.2 percent were injured, whereas 86.2 percent of 65 untreated ears were injured.-- Cartwright (108).

DDT in the form of an aqueous suspension (0.5 pound) or an emulsion (1 pound per 100 gallons of water) gave perfect control of tomato fruit worms.--Owens (284).

Comparative tests with DDT dust mixtures, calcium arsenate, and cryolite were made in southern California against the tomato fruitworm. Three applications were made at intervals of 2 weeks, at an average rate of 30 pounds per acre-application. The results, based upon the relative number of damaged tomatoes at harvesttime, showed that a 10-percent DDT dust mixture gave 92 percent control, a 5-percent DDT mixture 77 percent, and a 2.5-percent DDT mixture 81 percent. By comparison an undiluted calcium arsenate gave 81 percent control, and a 70 percent cryolite mixture 60 percent control. In another heavily infested experimental field 10-, 5-, and 2.5-percent DDT dust mixtures gave 97, 84, and 79 percent control, whereas the undiluted calcium arsenate gave 65 percent and the 70 percent cryolite 53 percent control. At Norfolk, Va., a 5-percent DDT dust was as effective as undiluted cryolite (90 percent) against this insect on Fordhook lima beans. --White (373).

On caged cotton plants DDT dusts tested gave the following percent mortalities: 84 from 4 percent DDT, and 73 from 1:1 basic copper arsenate-sulfur, both applied at 16 pounds per acre, as compared with 62 from calcium arsenate, 65 from lead arsenate, and 66 from cryolite (88 percent Na_3AlF_6), each at 8 pounds per acre. A spray application of 0.64 pound of DDT per acre did not kill so quickly as the same amount applied as a dust. Water sprays at the rate of 1.28 pounds of DDT per acre caused 100 percent mortality of third-instar bollworms, at 0.64 pound of DDT 89 percent, at 0.32 pound 66 percent, and at 0.16 pound 45 percent. In a field test two effective dust applications of DDT at 16 pounds per acre-application resulted in the following gains, in pounds of seed cotton per acre: 148 from 1 percent DDT, 154 from 2 percent, 238 from 4 percent, and 230 pounds from 8 percent. Calcium arsenate at the same rate gave a gain of 273 pounds per acre. In a large-plot test four applications of a 4 percent DDT-pyrophyllite dust at 16 pounds per acre-application gave a gain of 736 pounds of seed cotton per acre in comparison with 688 pounds from calcium arsenate at 15 pounds.--Loftin (247).

One application of Gesarol A-3 dust to green silk of sweet corn gave approximately 75 percent control. The constriction method by twine applied at the same time gave nearly 100 percent control.--Parker (287).

After treatments of tomatoes with cryolite-talc (1:1), cryolite-corn meal (1:10), calcium arsenate-lime (1:1), DDT 3 percent (Gesarol A-3), and the untreated control the following percentages of fruits were injured by fruitworms, 0, 1.7, 1.8, 0, and 2.4.--Wolfenbarger et al. (379).

A 3-percent DDT dust was applied a day or two after the corn silks appeared, so that the young worm would be killed after emerging from

the egg and before penetrating the silk. The method controlled the ear worm and the kernels developed full to the tip.--Russell (308).

In experiments in southern California corn fields heavily infested with the corn earworm, injection of white mineral oil containing 1 percent or more of DDT into the silks produced 85 to 99 percent of wormfree ears. In Illinois 91 to 100 percent of wormfree ears were obtained by either injection or atomization of 2 percent of DDT in undiluted white mineral oil.--Packard (285).

Heliothis virescens (F.), the tobacco budworm

In a field experiment at Florence, S. C., a 10-percent DDT dust mixture applied in the buds of tobacco plants by different methods gave from 88 to 100 percent kill of the tobacco budworm in 4 days.--White (373).

Laphygma exigua (Hbn.), the beet armyworm

In tests on caged cotton plants 2 percent DDT gave excellent results.--Loftin (247).

Prodenia praefica Grote, the yellow-striped armyworm

Insects swept from alfalfa were lightly dusted with a 3-percent DDT dust (A-3) and held in an insect net with alfalfa cuttings over night. About 50 percent of the armyworms were shriveled; when these were placed on fresh alfalfa cuttings and observed for 24 hours none of them fed.--Smith (324).

Trichoplusia ni (Hbn.), the cabbage looper

A series of experiments on cabbage caterpillars was conducted in field plots in southern California, at Charleston, S. C., and at Baton Rouge, La., against mixed populations, principally of the cabbage looper, the imported cabbage worm, the larva of the diamondback moth, and the cabbage webworm. Several species of Agrotinae and Heliothis armigera (Hbn.) were also present. In the Charleston area DDT appeared to be more toxic to the cabbage looper than to either the imported cabbage worm or the larva of the diamondback moth, and also more toxic than either rotenone or pyrethrum to the cabbage looper. The results of these experiments seem to warrant the tentative conclusion that heavy infestations of these three species of caterpillars may be controlled effectively by a 1-percent DDT dust applied at 10-day intervals, the first application being made as soon as feeding injury is apparent. This conclusion is drawn without consideration or regard for the residue factor. In one experiment on plots of cabbage, collards, and broccoli, a 1-percent DDT dust mixture applied at 10-day intervals from the time the first true

leaves appeared on the plants effectively controlled the cabbage looper, imported cabbage worm, and several species of Agrotinae. The same mixture was not effective against the cabbage webworm, but when the strength was increased to 2.5 percent adequate protection was obtained.--White (373).

Four applications of a 3-percent DDT dust gave good control; better than a 0.75-percent rotenone dust. Dusts containing 1 percent of DDT deposited from acetone or Velsicol AR-60 solutions gave even better control. In other tests the leaf-damage rating of 1-percent DDT dust was practically the same as that of 0.5 percent rotenone.--Apple (75).

Greenhouse tests with this species gave results almost identical with those for Pieris rapae L. Gesarol A spray 10 pounds (DDT 8 ounces) was much more effective than 5 pounds of lead arsenate.--Ross (306).

Cabbage plants were treated with DDT dusts (1/2 to 3 percent), applied at 28 to 30 pounds per acre. Sprays containing as little as 1/2 pound of DDT in 100 gallons of water were applied at 125 to 150 gallons per acre. In one test against thrips, DDT was dissolved in dichloroethyl ether (24 grams in 100 ml. total), emulsified, and applied at the rate of 1 pound in 100 gallons of water. These sprays and dusts gave outstanding control of the cabbage looper, the imported cabbage worm, and the diamondback caterpillar. None of the treatments compared favorably with nicotine sprays and dusts against cabbage aphid and turnip aphid. Results with DDT sprays and dusts on Thrips tabaci Lind. and others were erratic. However, the DDT-dichloroethyl ether treatment gave 99.2 percent control of thrips in a heavy infestation.--N. J. Agr. Expt. Sta. (275).

An application of Gesarol A-3 dust caused a complete clean-up 36 hours later. The larvae varied in size from half- to full-grown.--Janes (225).

Cabbage worms and loopers were controlled with a 3-percent DDT dust applied 5 times with a rotary hand duster to 70 plants of early cabbage. No larvae or damage were ever observed on the treated plants, whereas the checks were severely damaged. About a month after the last application of dust, larvae were found on the treated plants. Late cabbage and broccoli were treated with a 3-percent DDT dust and a 20-percent DDT spray. Counts made after the fourth application showed neither worms nor loopers on the treated plants but 116 worms and 64 loopers on the untreated plants. Lice colonies were present on 4 plants in the sprayed plots, and on 2 plants in the dusted plots; there were none on the check. No injury to the plants. The spray did not adhere well to the plants. --Gould (184).

In 1944 cabbage in the Kenosha, Wisc., area was treated with dusts containing 3 percent of DDT, 0.5 percent rotenone, or 20 percent of calcium arsenate. The DDT dust gave the best control and the average weight of the cabbage heads was greatest in the DDT-dusted plots. A spray containing 2 pounds of DDT (Gesarol AK-20) per 100 gallons of water gave better control than a cube spray or a lead arsenate spray each containing 4 pounds per 100 gallons.--Allen and Brunn (71).

See Pieris rapae.--Granovsky (187).

See thrips on beets (p. 43).--Anon. (49).

Phaloniidae

Anticarsia gemmatilis (Hbn.), the velvetbean caterpillar

Excellent control of this caterpillar on peanuts and soybeans was obtained with a single application of 3-percent DDT dust or a DDT spray.--Packard (285).

Phycitidae

Acrobasis caryae Grote, the pecan nut casebearer

A 0.20-percent DDT spray reduced infestation by about one-third.--Hamilton (200).

Gesarol SH-5 at 1/2 gallon per 100 gallons of water, and Gesarol A-20 at 2 pounds, reduced the infestation to 44 and 40 percent, as compared with 60 percent in the checks. Timing the sprays with hatching is very important. --Okla. Agr. Expt. Sta. (278).

Results obtained with DDT were promising enough to warrant further tests.--Baker and Porter (81).

Ephestia elutella (Hbn.), the tobacco moth

In laboratory experiments at Richmond, Va., undiluted DDT was used in an acetone-oil solution. The solution was atomized into a modified Peet-Grady chamber. The test insects were adults of the tobacco moth and the cigarette beetle. A 5 percent DDT-oil solution, used at the rate of 100 cc. per 1,000 cubic feet, resulted in 97 percent kill of the tobacco moth in 3 days and 71 percent kill of the cigarette beetle in 5 days. A 15-percent solution killed 98 and 90 percent of the moths and beetles, whereas pyrethrum-oil spray (0.2 percent of pyrethrins) gave mortalities of 100 and 46 percent of the moth and beetle, respectively. A 10-percent DDT dust mixture, prepared by mixing pyrophyllite with an oil solution of DDT and then blown into the dust chamber at the rate of 3 ounces per 1,000 cubic feet, killed 48 percent of the tobacco moths and 93 percent of the cigarette beetles. A

15-percent solution of DDT in oil sprayed on packages of cigarettes did not prevent them from becoming infested during an exposure of 30 days.--White (373).

Etiella zinckenella (Treit.), the lima bean pod borer

Three applications of 3-percent dust (Gesarol A-3) were made May 21, 25, and 26 on lima beans at the rate of 30 pounds per acre. Rains within 24 hours after the second and third applications washed off the dust. An average of 43.8 percent wormy pods occurred in the dusted plots and 36.2 percent in the checks.--Ewart (145).

Mineola vaccinii (Riley), the cranberry fruit worm

Two applications of each of three dust mixtures were compared in a cranberry bog in New Brunswick. The percentage of berries injured with the different mixtures were as follows: Gesarol A-3 dust (3 percent DDT) 34.7; Lethane B71 35.4; gypsum-cryolite (70:30) 42.4; check 75.5. In two other tests the Gesarol gave approximately the same results as the gypsum-cryolite dust.--Ross (306).

Plodia interpunctella (Hbn.), the Indian meal moth

In tests in grain-elevator bins pyrethrum applied either as a spray or an aerosol gave much better control of both adults and larvae of the Indian meal moth than did a DDT aerosol. The pyrethrum aerosol contained pyrethrum extract 5 percent (pyrethrins 1 percent), either oleic acid or oil of sesame 2 percent, and Freon 93 percent; the pyrethrum spray contained pyrethrum extract 10 percent (pyrethrins 0.4 percent) in a high-grade oil such as Deobase, Pensolene, or Imperial No. 9, and the DDT aerosol consisted of DDT 5 percent, cyclohexanone 10 percent, and Freon 85 percent. Adults were more susceptible than the larvae to DDT aerosol. In another test a kerosene spray containing 5 percent of DDT was applied to larvae on the ceiling of a grain store room. Only a few of the larvae dropped to the floor and 24 hours later there was no significant decrease in the numbers of larvae on the sprayed areas. Test insects were exposed on wheat treated with small amounts of DDT combined with Almicide, a chemically inert mineral dust which has the property of promoting excessive water loss from insects. Although the Almicide alone caused no mortality at the dosage applied (maximum rate 1 part dust in 15,000 parts wheat), it appeared to exercise a marked influence on the insects when combined with DDT, e.g. after 5 days' exposure, at a dosage of 1:28,000, undiluted DDT was not significantly more effective than the DDT-Almicide dust containing only 25.6 percent of DDT. Wheat mixed with DDT-Almicide dust (containing 18 percent of DDT) in the ratio 15,000:1 killed 15 percent of the larvae of the Indian meal moth after 10 days' exposure. --Ross (306).

To 500-gram samples of wheat, 0.05, 0.025 and 0.005 percent of technical DDT was added. The samples were placed in glass jars together with larvae of the Indian-meal moth. At the end of the first week all three dosages of DDT

gave a complete kill. Seeds of watermelon, corn, tomato, and lettuce treated with 0.05 percent of DDT were protected against infestation for 2 months, whereas untreated seed was heavily infested.--Cotton et al. (120).

The larvae in a dairy building were apparently killed by a DDT residual spray.--Ross (306).

Larvae appear to be resistant to DDT dust. Applied as an aerosol and as an oil-base spray under precautions, DDT was not so effective as pyrethrum similarly applied.--Smallman (322).

Pieridae

Colias eurytheme Boisduval, the alfalfa caterpillar

In laboratory tests a 3-percent DDT dust gave complete control in 18 hours.--Okla. Agr. Expt. Sta. (278).

In laboratory tests Gesarol A-3 dust killed 100 percent of full-grown caterpillars.--Hamilton (200).

Pieris rapae (L.), the imported cabbage worm

In greenhouse tests on larvae collected in the field, this species was very susceptible to DDT with kills approaching 100 percent by sprays containing as little as 2 to 4 ounces of DDT per 100 imperial gallons. A 15-day-old spray deposit of DDT, which had been kept dry, was just as effective as a fresh deposit. Although DDT appeared to have no direct repellent action in the sense that larvae avoided the sprayed surfaces, it caused most of the larvae to leave the plant soon after they had done a very small amount of feeding on treated foliage, or after the insects themselves had been sprayed and placed on unsprayed plants.--Ross (306).

The imported cabbage worm, the cabbage looper, and the diamondback moth were completely controlled by a 5-percent DDT dust in combination with 5 percent of yellow copper oxide in pyrophyllite dusted lightly five times during the season. The plants in the check plots were so badly riddled that not a single edible head was formed. The DDT dust was by far the most effective of several insecticides tried. The cabbage plants treated with a DDT combination were absolutely free from holes and assumed a healthier and conspicuously greener appearance in comparison with all other plots.--Granovsky (187).

Same as for Trichoplusia ni (Hbn.).--Allen and Brunn (71); Apple (75).

A trial dusting of cabbage with a 3-percent DDT dust gave perfect control of cabbage worms, whereas an adjacent row, untreated, was badly riddled by worms.--Cartwright (108).

The cabbage worm, cabbage looper, and diamondback moth were controlled completely by applications of Gesarol A-3 (3-percent DDT) dust to cabbage every 5 weeks from May 15 until harvest, July 15. This dust apparently increased growth slightly and prevented head splitting at maturity when renewed growth started due to rain.—Parker (287).

See Trichoplusia ni.—White (373); N. J. Agr. Expt. Sta. (275).

The treatments used were as follows: 1, 2, and 3 percent DDT dusts (talc base), 1/2, 1, and 2 percent DDT sprays, an emulsible liquid spray, 1 ounce of the active ingredient in 100 gallons of spray, and a paris green spray. The 1-percent dusts and 1/2-percent sprays gave as good control as did the higher concentrations when applied every 2 weeks. An emulsible DDT liquid spray gave perfect protection against all the cabbage worms for 2-3 weeks when applied at a rate that gave only 1 ounce of the active ingredient in 100 gallons of spray. At one time 5 weeks elapsed between treatments on the plots dusted with a 3-percent DDT dust. At the end of this period only 3 percent of the plants were infested with worms as compared with 50 percent on the paris green plots, which had been sprayed every 2 weeks. The untreated plots showed an 80 percent infestation.—Russell (308).

Plutellidae

Plutella maculipennis (Curt.), the diamondback moth

A dust containing as little as 0.5 percent of DDT gave good control of this insect. An aerosol containing 3 percent of DDT also gave excellent control of this pest on large broccoli plants.—Walker (365, 366).

Psychidae

Thyridopteryx ephemeraeformis (Haw.), the bagworm

Actively feeding bagworms were removed from a badly infested sycamore tree and placed on uninjured foliage from a nearby tree. In the laboratory, a single spray of DDT, at the rate of 1 pound of DDT in 100 gallons of water plus 1/4 pound of Areskap, was applied to branches containing bagworms. The infested tree was also sprayed. In the laboratory test 28 percent of the bagworms were dead 24 hours after treatment. The tree was half defoliated and heavily infested when treated. Defoliation was completed after spraying.—N. J. Agr. Expt. Sta. (275).

This insect was readily controlled with DDT (0.1 to 1 percent) applied as an emulsion in small-scale tests.—Craighead and Brown (125).

Pyralididae

Diatraea saccharalis (F.), the sugarcane borer

A 10-percent DDT dust was less effective than undiluted cryolite.—Packard (285).

Pyraustidae

Diaphania hyalinata (L.), the melonworm

D. nitidalis (Stoll), the pickleworm

In tests conducted for the control of these insects on cantaloups, a dust containing 3 percent of DDT gave very promising results.--Walker (365, 366).

Three applications of Gesarol A-3 dust at the rate of 30 pounds per acre reduced cantaloups infested with the melonworm to 2.5 percent. No burning of plants resulted.--Ewart (145).

A 3-percent DDT dust was effective against pickleworms on squash and cucumber. Untreated cantaloup plots produced 359 cantaloups, 12 of which were damaged by the pickleworm and 105 by the granulate cutworm, Feltia subterranea (F.). Plots dusted four times with DDT produced 358 cantaloups, only 1 of which was damaged by the pickleworm.--Cartwright (108).

A 3-percent DDT dust was about equal to a 33-percent cryolite dust against pickleworms in field tests in North Carolina. A 1-percent DDT dust gave considerable control.--Fulton (162).

An acre of cantaloups infested with pickleworms was divided into 60 plots, dusted, and each treatment replicated 10 times. Dusting began at blooming and was continued at weekly intervals until 10 days before harvest. Four applications were made at concentrations ranging from 15-20 pounds per acre to 25-30 pounds per acre. The average percentage of infested melons at harvest was as follows: 1-percent DDT 5.5, 2-percent DDT 4.4, 3-percent DDT 4.4, 1/2-percent rotenone 8.9, 30-percent cryolite 7.3, and check 11.2.--Lyle (249).

Hellula undalis (F.), the cabbage webworm

Same as for Trichoplusia ni.--White (373).

Loxostege similalis (Guen.), the garden webworm

A DDT aerosol gave excellent kills of garden webworm on spinach.--Ditman (133).

Pachyzancla phaeopteralis (Guen.), a grass webworm

A 10-percent DDT dust applied to a lawn at the rate of 10 pounds per acre killed more than 90 percent of these larvae. The principal grass in this lawn was carpetgrass (Axonopus compressus (Swartz.) Beauv.).--Ingram et al. (222).

Phlyctaenia rubigalis (Guen.), the greenhouse leaf tier

Greenhouse tests showed that this species had about the same degree of susceptibility to DDT as the diamondback moth.—Ross (306).

Pyrausta nubilalis (Hbn.), the European corn borer

In 1944 three applications of DDT with ground-sprayer equipment near Toledo, Ohio, at 5-day intervals to early-market sweet corn gave excellent borer control. A 10.8 percent DDT-pyrophyllite dust gave 97.9 percent reduction of borers in the plant and 99.2 percent reduction in the ears, when applied with a wheelbarrow sprayer run by a gasoline engine and applied with a hand nozzle that produced a solid cone of spray. Four applications of dusts containing 0.75, 1.5, 3, and 6 percent of DDT in pyrophyllite were made 5 to 7 days apart with a ground machine to sweet corn in dosages of 0.3, 0.6, 1.2, and 2.4 pounds per acre-application. Borer reduction increased with each increase in the dosage, and at the highest rate provided 95 percent reduction of corn borer larvae infesting the ears, even though the applications were begun too late for best results against newly hatched larvae. The yield resulting from treatments applied at a rate of 2.4 pounds of DDT per acre-application was graded 89.9 percent salable and 85.1 percent No. 1 and borer-free. On the variety Evergreen four airplane applications 3 to 5 days apart of a concentrated spray containing 8.9 percent of DDT in white oil, at the rate of about 2.25 gallons per acre, provided borer reductions in plants of 98 percent, with all ears salable size and borer-free in the center rows of the treated swath. DDT in dust form applied by airplane to the same variety was somewhat less effective than the concentrated spray. Aerial dust treatments resulted in 82.3 percent reduction of borers in the ears, and a yield in which 85.6 percent of the ears were No. 1 and borer-free. All treatments resulted in an increase in the number of salable ears per plot. Tests were also made with Gesarol spray insecticide (.5 percent DDT). Areskap was added to all sprays at the rate of 1/3 pound per 100 gallons of water. The concentrated spray contained the following ingredients: DDT, technical (GNB-A-DDT) 0.67; Solvent, petroleum distillate 1.34; white-oil vehicle, Superla grade (125 seconds Saybolt) 5.36; and emulsifying agent (Triton X-100, an aralkyl polyether alcohol) 0.16 pound per gallon.--Batchelder and Questel (83); also Packard (285).

A spray containing 4 pounds of cube (5.5 percent of rotenone) and 6 ounces of Areskap per 100 gallons of water, applied on four dates, gave a control of 80 percent, whereas a spray containing 0.026 percent of DDT gave a control of 77 percent. A 3-percent DDT dust gave a control of 67.3 percent. With a 0.026-percent DDT spray, applied 4 times with a power sprayer and a three-row boom carried over the corn the control was 96.2 percent, whereas, a 0.024-percent rotenone spray gave 96.1 percent control.--Apple (75).

DDT is promising for this insect.--Annand (74).

DDT is being tested against the European corn borer, and the results have been very encouraging, particularly in sweet corn.--Aamodt (60).

A Ryania insecticide gave better results than 3 percent DDT against the corn borer in New Jersey, but the percentage of salable ears of corn produced were about the same with both treatments.--AIF (65).

Five applications of a 3-percent Gesarol dust were applied with a rotary hand duster June 7, 11, 16, 20, and 25, 1944, to two 15-stalk rows of Golden Cross Bantam sweet corn as a plot replicated six times. Most larvae had left the stalks by harvesttime, July 26 and 27. Dissections of stalks showed that 9 percent of the treated plants and 62 percent of the untreated plants had been infested. There was no injury from the treatment. Plants treated with a cube spray (4 pounds of a 5-percent rotenone material in 100 gallons) had 1.4 percent of the stalks infested. More research is needed before recommendation.--Gould (184).

A 3-percent DDT dust gave a greater reduction in both the first and second generation borer population than a 1-percent rotenone or a 4-percent nicotine dust. The DDT interfered with growth of the corn.--N. J. Agr. Expt. Sta. (275).

See Empoasca fabae; also Popilia japonica.--Wolfenbarger et al. (379).

Sphingidae

Ceratomia catalpae (Bdv.), the catalpa sphinx

The larvae were readily controlled with DDT (0.1 to 1 percent) applied as an emulsion in small-scale tests.--Craighead and Brown (125).

Protoparce quinquemaculata (Haw.), the tomato hornworm

A small number of full-grown larvae dusted with Gesarol A-3 immediately showed signs of severe irritation by violently swinging the anterior half of the body from side to side, together with defecation and excessive exudation of moisture. Later the larvae fell from the plant and all died after shrinking greatly. In a field test at Chatham, Ontario, tobacco plants were sprayed with DDT at 16, 8, and 4 ounces per 100 imperial gallons of water and in each case 100 percent control resulted.--Ross (306).

A DDT aerosol gave excellent kills of hornworms on tomatoes.--Ditman (133).

Same as Macrosiphum solanifolii (Ashm.).--N. J. Agr. Expt. Sta. (275).

P. secta (Johan.), the tobacco hornworm

In field experiments at Florence, S. C., and Oxford, N. C., neither a 5- or a 10-percent DDT mixture gave a satisfactory reduction of the tobacco hornworm. In laboratory tests at Oxford fifth-instar tobacco hornworms were not affected by the 10-percent mixture, but the same instar of the tomato hornworm succumbed readily. In comparable tests with third instars 100 percent mortality of the tomato hornworm was obtained in 24 hours in each of seven replicates, whereas the mortality of the tobacco hornworm averaged 12 percent in 24 hours and 35 percent in 196 hours. There was very little feeding of either species on the treated foliage.--White (373); Stahl et al. (331).

Some caged tomato plants were dusted with 3 percent DDT and worms put on them, while others were dusted with the worms in place. More worms died when they were present to receive the dust. The percentage of kill was variable in the different tests, with about 50-percent mortality. The tobacco hornworms were less affected than the tomato hornworms on the same plant.--Gould (184).

Tineidae

(Clothes moths)

Garments impregnated with DDT are mothproof and remain so for a very long time.--Buxton (100).

Tortricidae

Archips argyrospila (Wlk.) the fruit tree leaf roller

Apple trees infested with nearly mature larvae were treated with a spray containing 2.5 quarts of 20 percent DDT in oil, with emulsifier (SH-20), per 100 gallons of water. Within a short interval after spraying, the larvae left the foliage and were hanging by their silken threads. Many dropped to the ground; none were found on the trees 48 hours after spraying, whereas unsprayed trees remained infested. The spray caused a spotted leaf injury.--Borden and Jeppson (90).

Archips fumiferana (Clem.), the spruce budworm

Tests with high-powered ground equipment, conducted at Fort Collins, Colo., demonstrated that the spruce budworm can be controlled with dosages as low as 2.5 pounds of DDT per acre, applied as an emulsion in linseed oil or as a finely divided alcohol-water suspension. Some of the sprays were applied prior to larval activity in the spring; others were used when the larvae were one-half to full grown. There were indications that the early applications, which killed the young larvae as they began feeding, were partially effective in killing the moths several weeks later; therefore,

one treatment may result in control of two generations of some species of insects.--Craighead and Brown (125).

In Canada a DDT insecticide distributed from a helicopter was effective.--Anon. (6).

Cyclohexanone-oil sprays containing 5 or 10 percent of DDT were applied with a hand atomizer and also by airplane at the rate of 5, 3 or 2 pounds of DDT per acre. The sprays killed apparently all adults at the time of application and the plots remained practically free of moths for the remainder of the season, in spite of their abundance in the areas adjoining the plots. Moths entering the plots and those emerging from pupae appeared to have been killed in considerable numbers by the DDT residue on the foliage. The sprays were not effective however, against the pupae, eggs, or hatching larvae. Observations over a 6-week period showed only 10 percent mortality of the young larvae seeking, or in, their winter quarters.--Ross (306).

It may be possible to control two generations of the spruce budworm with one application of DDT. It is also probable that fairly good coverage at the beginning of an outbreak would prevent subsequent build-up of infestation, and satisfactory control might be obtained with only one application.--Sheals and Craighead (314).

Archips rosaceana (Harr.), the oblique-banded leaf roller

DDT applied both as a dust and as a spray gave practically 100 percent control on 250 acres of raspberries and saved the crop. The deadly effect of the insecticide remained on the foliage for at least a month. The DDT was not unpleasant to handle and contrary to some fear, it apparently was not harmful to bees, even though the application had to be delayed until the full-bloom stage because of the late arrival of the material.--Burtner (99).

DDT is being recommended for the control of this insect in Oregon. --Childs (110).

Experiments carried on in the laboratory at Corvallis, Oreg., in the winter of 1943-44 proved that the DDT applied to the raspberry foliage would kill oblique-banded leaf roller worms that crawled over it.--Burtner (98).

At Gresham, Oreg., various DDT insecticides applied on small plots and fields involving some 250 acres of raspberries gave practically 99 percent control of oblique-banded leaf roller with no apparent damage to bees or other beneficial insects. Insecticides tested were as follows: (1) 1½ percent DDT dust, one application 2 weeks before blossoming period; (2) Gesarol A-20, 2 pounds per 100 gallons, one

application 2 weeks before blossoming period; (3) 5 percent DDT in oil, 2 quarts per 100 gallons, one application 2 weeks before blossoming period.--Gray and Schuh (189).

Argyrotaenia mariana (Fern.), the gray-banded leaf roller

In a field test 16 ounces of DDT per 100 imperial gallons of water gave control approximately equal to that obtained with 5 pounds of lead arsenate.--Ross (306).

Cnephasia longana (Haw.), the strawberry fruitworm

Gesarol A-3 dust, applied in May with a hand duster to 120 newly planted filbert trees (1½ acres) in the Willamette Valley, gave practically 100 percent control.--Thompson (346).

Unidentified Lepidoptera

Lepidopterous caterpillars in an alfalfa field treated with a 3-percent DDT dust at the rate of approximately 28 pounds per acre appeared to have been killed.--Michelbacher et al. (257).

HYMENOPTERA

Apidae

Apis mellifera L., the honeybee

DDT has been found to be highly toxic to bees, both as a contact insecticide and as a stomach poison. If DDT ever comes into general use as an insecticide, it conceivably might upset the balance of natural conditions by destroying the pollinators that produce many of our food crops. --Anon. (43).

See Archips rosaceana (Harr.).--Burtner (99).

After an application of a DDT spray to sweet grapes (New York Muscats), wasps, bees, and Japanese beetles disappeared as if by magic. --Bromley (96).

Small cotton plants were dusted with 3-percent DDT dust (A-3) at the rate of 25 to 30 pounds per acre. Honeybees usually flew directly to freshly opened flowers and therefore usually did not alight on dusted surfaces; the few bees that did crawl over the bracts and corolla into the flower showed little or no apparent effect of the insecticide. --Smith (324).

Unwanted honeybee colonies were eradicated slowly by 20 percent DDT (Gesarol A-20). Three percent DDT was ineffective when it was blown into colony entrances.--Wolfenbarger et al. (379).

To avoid killing bees, open blossoms should not be sprayed with Gesarol, although its contact action against bees is less than against flies, beetles, and other pests.--Kobel (239).

Bees were abundant in an alfalfa field treated with a 3-percent DDT dust at the rate of approximately 28 pounds per acre and were not perceptibly injured.--Michelbacher et al. (257).

Careful examination of the gound under hairy vetch at Oregon City, Oreg., disclosed that 5-percent DDT dust had killed insects of several species. No dead bees were found and no decrease was noted in the number of honeybees that were swept from hairy vetch dusted with DDT. --Rockwood and Reeher (303).

Individual honeybees placed on sheets of paper dusted with 1 percent of DDT in kaolin and covered with a beaker were totally paralyzed in 19 minutes and killed in 110 to 130 minutes.--Sen (311).

It is not yet known just how serious a menace DDT spray residues on fruit trees and cover crops in orchards will be to honeybees, but experiments during 1944 showed that, although the bees were readily killed when confined in cages with sprayed material, the effect of visiting sprayed blossoms in the field may not be so serious as at first feared.--Ross (306).

DDT was applied to raspberries while in full bloom. Bees that worked the sprayed flowers were caged and compared with those taken far away from the area. The bees from the sprayed areas appeared to live just as long as those from the unsprayed sections. In other experiments DDT was toxic to bees confined in quarters sprayed with the insecticide.--Burtner (98).

See Unidentified thrips.--Anon. (49).

Formicidae

Atta cephalotes (L.), the coushi ant

In a laboratory experiment in British Guiana 7 specimens of the soldier caste of Atta cephalotes were placed in a glass container the floor of which had been dusted with DDT. Alongside them was placed a suitable control experiment consisting of soldier ants from the same nest. Two hours later all the ants in contact with the insecticide were obviously affected, the usual tremulous movements in the limbs and their lack of coordination in locomotion being evident; 6 hours later the

affected ants were in a moribund condition, being on their backs and incapable of locomotion although movements of the legs, antennae, and mouth parts occurred occasionally; and after 24 hours all the ants were dead. The ants in the control remained unaffected throughout the test period.--J. (223).

Camponotus herculeanus pennsylvanicus (Deg.), the black carpenter ant

Carpenter ants in porch columns and in the hollow center of maple trees were eliminated with 3-percent DDT dust.--N. J. Agr. Expt. Sta. (275).

Camponotus spp., carpenter ant

In the Superior National Forest in Minnesota 17 log cabins were sprayed with 1- and 5- percent solutions of DDT in kerosene. Satisfactory control was obtained with a 5-percent solution.--Craighead and Brown (125).

Iridomyrmex humilis Mayr, the Argentine ant

A kerosene spray containing 5 percent of DDT is extremely toxic to Argentine ants and has been successfully used around the casings of doors and windows of masonry buildings. The ordinary frame house, however, provides many entrances for this insect; under these conditions, standard Argentine ant poisons placed around the outside of the house are far more effective than an attempt to treat all the interior.--Freeborn (160).

Lasius niger alienus americanus Emery, the cornfield ant

Three applications at 4- to 8-day intervals of a 3-percent DDT dust (a small pinch per nest) failed to give complete control, although the number of nests was reduced by about four-fifths.--Ross (306).

Monomorium pharaonis (L.), the Pharaoh ant

A field test with 1 percent of DDT in kerosene was disappointing. A further trial in which the concentration was 5 percent and the walls were sprayed to leave about 100 mg. of DDT per square foot achieved a very great reduction in infestation.--Buxton (100).

Solenopsis molesta (Say), the thief ant

An ant (presumably the thief ant) attacking beets was killed and driven away by one treatment of Gesarol A-3 dust.--Parker (287).

Thief ants in a bakery were eliminated by the use of a 3-percent DDT dust.--N. J. Agr. Expt. Sta. (275).

Tetramorium caespitum (L.), the pavement ant

A 3-percent DDT dust was effective.--Haseman (203).

Pavement ants attacking insulation of houses were destroyed by painting sills and surrounding structures with 3 percent of DDT in kerosene.--N. J. Agr. Expt. Sta. (275).

Wasmannia auropunctata (Roger), the little fire ant

In preliminary tests with DDT favorable results were obtained in the control of the little fire ant on citrus trees in Florida.--Baker and Porter (81).

Unidentified species

A very heavy infestation of ants (Formica sp.) was tunneling in the soil of some flats in a greenhouse and bringing tomato seed to the surface. Three percent of DDT in talc was applied to the flats and beneath the bench on which they were placed. No live ants were found 18 hours later. A few dead ants were found by digging in the flats.--Fletcher (155).

DDT is a contact poison to Formicides.--Domenjoz (135).

Examination of the ground under hairy vetch at Oregon City, Oreg., disclosed that 5-percent DDT dust had killed ants.--Rockwood and Reeher (303).

Sphecidae

Mud-dauber wasps were quickly killed when they walked over wire screens treated with water suspensions of DDT in the form of Gesarol A-20 (0.8 pound in 100 gallons).--Fluke and Pond (157).

Diprionidae

Diprion frutetorum (F.), an imported pine sawfly

Neodiprion lecontei (Fitch), the red-headed pine sawfly

Complete control of both species was obtained with 2 pounds of DDT in 2 gallons of oil per acre. In treatments applied from an airplane against the red-headed pine sawfly, the spray was mixed at the rate of DDT 1 pound, cyclohexanone 1 pint, and a horticultural spray base heavy oil about 7 pints (enough to equal 1 gallon of mixed spray). Against

the imported pine sawfly 1 1/2 pints of xylene were substituted for the 1 pint of cyclohexanone and the solution seemed perfectly satisfactory. --Dowden et al. (136).

Complete control of the red-headed pine sawfly in a red pine plantation in northern New York was obtained by applying 2 1/2 pounds of DDT per acre. On the fringes of this sprayed area, where the spray drifted, complete control was obtained with a dosage believed to be not more than 1 pound of DDT in 1 gallon of liquid per acre.--Craighead and Brown (125).

Trichogrammatidae

Trichogramma sp.

See Diatraea saccharalis.--Ingram et al. (222).

Vespidae

Vespula arenaria F.

A small quantity of Gesarol A-3 dust (3 percent DDT) was applied with an insecticide puffer to the exit holes of two active wasps' nests under the eaves of two neighboring garages at Westboro, Ont. No wasps were seen around the nest the next day and none issued from the nests when disturbed. The nests were cut down on the second day and found to contain numerous living larvae and pupae and a few adults which were unable to fly. The wasps had apparently got the dust on their bodies while passing in and out of the nests and most of them after leaving had been unable to return.--Ross (306).

Unidentified wasps

See Apis mellifera.--Bromley (96).

DIPTERA

Anthomyiidae

Fannia canicularis (L.), the little housefly

Same as for Musca domestica.--Ross (306).

Hylemya antiqua (Mg.), the onion maggot

Gesapon No. 18, 1 gallon (approx. 8 oz. of DDT) per 100 imperial gallons of water was applied to seedling onions at the rate of 1 gallon per 120 feet of row. One series of plots was treated on May 30, and a second series on May 30 and June 2. Results to June 30 were as follows: One application, 21 seedlings dead, 251 living, seedling mortality 8.3 percent; two applications, 46 dead, 290 living, mortality 15.8 percent;

check, 166 dead, 468 living, mortality 35.4 percent.--Ross (306).

Hylemya brassicae (Bouche), the cabbage maggot

These flies are controlled by watering each plant with 100 cc. of 1 percent Guesapon at the time they are set out.--Geigy Colour Co. (166).

The cabbage maggot was not controlled by eight applications of 5 percent DDT in light summer spray oil, average about 1/2 gallon per acre, made by hand atomizer from June 6 to August 1.--Gray (188).

Dusts were applied from shaker cans at the rate of 20 pounds per acre. Applications were made before egg deposition by adults, and 11 days later the DDT dusts (2 and 4 percent) gave only slightly better results than the checks. Calomel (4 percent) gave 96.4 percent reduction of the maggot population.--N. J. Agr. Expt. Sta. (275).

Hylemya floralis, radish fly

Same as for H. brassicae.--Geigy Colour Co. (166).

Calliphoridae

Calliphora vomitoria (L.)

DDT is a contact poison.--Domenjoz (135).

Lucilia (= Phaenicia) sericata (Meig.), greenbottle fly

Laboratory tests showed than an emulsion containing 0.5 percent of DDT was toxic to laboratory-bred flies dipped in it. Welsh mountain sheep dipped in a bath containing 0.3786 percent of DDT remained free from strike for 42 days. The effectiveness of the dip lies in its direct action on the blowfly. Tests in which gravid females of L. sericata were kept in contact with the fleece of a DDT-dipped sheep showed that even 5 weeks after dipping 30-60 seconds' contact was sufficient to have a toxic effect on the flies.--Cragg (124).

Lucilia caesar (L.)

Same as for Musca domestica.--Ross (306).

Chironomidae

Phlebotomus spp., sand flies

In Panama two tests were made in which houses were sprayed inside

and out with a 2.5-percent solution of DDT in kerosene, but in both cases the tests were interrupted after a short time. In one house no sand flies were seen or reported 4 and 8 days after the spraying; in the other house, no sand flies were seen or no bites received for 4 or 5 days.--Gorgas Memorial Laboratory (182).

Culicidae

Aedes aegypti (L.), the yellow-fever mosquito

Pieces of filter paper were treated with a range of doses of pure DDT, in a volatile solvent, so that the surface presented to test insects was dry; all insects were exposed at the same temperature and for the same period. The lethal dose for Aedes aegypti was 0.001 mg. of pure DDT per square centimeter.--Buxton (100).

DDT is promising for mosquitoes.--Annand (74).

Gammexane [benzene hexachloride] scattered at the rate of 1/2 pound per acre killed 97 percent of the larvae in 2 days and 100 percent in 3 days, as compared with kills of 43 percent in 2 days and 97 percent in 3 days with the same amount of DDT.--Anon. (52).

Aedes sollicitans (Wlk.), the salt-marsh mosquito

Under laboratory conditions colloidal solutions of DDT show very high toxicity to larvae of A. sollicitans and Culex pipiens L. but low toxicity to pupae of the same species. The toxicity to pupae can be materially increased by incorporating DDT into a mosquito oil emulsion. In dust form DDT proved ineffective against pupae and of considerably lower toxicity to larvae of subsurface-feeding species than it did in either an oil emulsion or colloidal solution. Toxicity to larvae can be increased by the use of certain solvents for incorporating the DDT into the dust. Under field conditions DDT dusts were practically ineffective against pupae, only of moderate toxicity to larvae of subsurface-feeding species, but highly toxic to larvae of surface-feeding species. As an oil emulsion, DDT gave effective control of both larvae and pupae in certain breeding places and poor control in other places, especially where pollution was present.--Ginsburg (178).

Dilutions of 1 part DDT to 50,000,000 parts of water were very toxic to larvae of Aedes sollicitans and Culex pipiens in the laboratory. Toxicity to pupae of the same species was low. In the field, DDT preparations usually did not last any longer than mosquito oil applied under similar conditions, and were even less effective against pupae than in the laboratory. However, DDT preparations were more effective against anopheline larvae than against subsurface-feeding larvae. Emulsion 50-D, applied at the rate of 50 to 70 gallons per acre, gave 100 percent kill of anopheline larvae and lasted for 8 days. In general,

on subsurface-feeding larvae it appeared that DDT was most toxic when applied in colloidal dispersion, less toxic when applied in oil emulsions, and least toxic when applied as dusts.--N. J. Agr. Expt. Sta. (275).

Aedes vexans (Mg.)

An emulsion of DDT (64 percent kerosene containing 2 percent of DDT, 34 percent water, and 0.5 percent sodium lauryl sulfate) applied at the rate of 7 gallons per acre [equivalent to 1.16 pounds DDT] to a woodland pool gave 90-95 percent control and the effectiveness lasted 4 weeks.--Ginsburg (178).

Anopheles albimanus Wied.

In Panama over 200 tests with heavy dosages of DDT applied either as floatable dusts or in oils on the main types of mosquito breeding areas were effective for 2 to 6 weeks in heavy growths of Jussiaea, but only from 2 to 4 weeks in the more open Naias. Long lasting effects depend upon the protection of the floating dust or oil film. Under river margin conditions, DDT remained effective for a maximum of only 6 weeks under the most favorable conditions. Dosages of as little as 0.02 pound of DDT per acre in dust and 0.01 pound per acre in oils or emulsion gave perfect to near perfect kills of anopheline larvae in 24 hours. In the use of oils, it was found most satisfactory to use only enough oil to cover the area to be treated. Thus 0.05 to 0.025 pound of DDT in 1 to 4 pints of used crankcase oil per acre gave better killing results than the same amounts of DDT in larger quantities of oil. An emulsion concentrate, when mixed with water and applied at the rate to give about 0.02 pound of DDT per acre, gave perfect to near perfect 24-hour kills of both anopheline and culicine larvae. This concentrate is more difficult to apply and, in concentrations as high as 200 ml. per acre, is quite lethal to fish. Comparative tests of paris green-talc and DDT-talc dusts indicated that the DDT dust was 5 to 10 times as toxic to anopheline larvae as the paris green dust. DDT dusts or oils, unless used in very heavy doses, were ineffective in controlling culicine larvae. DDT in emulsion was equally effective against culicines and anophelines. Other tests to control adult mosquitoes were also conducted. DDT in oil was applied by hand sprayers to the ground in jungle areas. All mosquitoes disappeared for 1 to 2 days in the quarter- to half-acre treated plots. Tests in an open orchard killed mosquitoes but infiltration was so rapid that biting rates soon returned to normal. Five liters of a 5-percent DDT solution in kerosene, applied with a knapsack sprayer, gave nearly complete kill of mosquitoes on a 1-acre plot in an open cacao plantation. Checks 48 hours later showed complete returns to normal mosquito populations.--Gorgas Memorial Laboratory (182).

Anopheles crucians Wied.

Same as for Aedes sollicitans.--Ginsburg (178).

Anopheles funestus Giles

A dosage of only 0.10 cc. per square yard of a Diesel oil solution containing 5 percent of pure DDT killed all larvae, and continued to kill for 4 days. This dose is extremely small, corresponds to 24 grams or 0.8 ounce per acre, a figure well below the conventional 2 to 4 ounces, even allowing for the fact that pure p,p'-DDT was used. Even more remarkable, a tenth of this dose (0.01 cc. per square yard, or 0.08 ounce per acre) killed all larvae but had no lasting effect.--Buxton (100).

Anopheles maculipennis Mg.

Even extremely low doses of DDT, 50 mg. per square meter (10.8 sq. ft.), have some effect on mosquitoes although this is very temporary. With doses of 200 mg. per square meter or more the treated surface remains lethal to the maculipennis group for 10 weeks. Higher doses give a slightly prolonged effect which is not in direct proportion to the amount applied. In practice a dose of 500 mg. per square meter should be aimed at and it should be considered to be effective for 8 weeks.--Buxton (100).

Anopheles quadrimaculatus Say, the common malaria mosquito

Up to 200 adults were found resting in 7 by 9 foot wall tents in a summer camp near Marcellus, N. J. Additional adults were continually emerging from a large breeding area in a nearby lake. Groups of tents were treated with the following: 3, 1, or 0.5 percent of DDT in kerosene, DDT emulsion diluted 1 to 4, DDT emulsion diluted 1 to 9.3, DDT dust (talc), N. J. Pyrethrum Larvicide diluted 1 to 10, and kerosene. The DDT emulsion contained 66 percent of kerosene, 2 percent of DDT, and 0.5 percent of sodium lauryl sulfate. A single thorough application was made with a knapsack sprayer or hand duster. Some tents were sprayed with a small power sprayer. DDT-sprayed tents were almost entirely free of resting adults for the 3 1/2-week test period, as compared with 2 days' protection with N. J. Pyrethrum Larvicide. DDT dust showed little effectiveness. Kerosene apparently had some repellent effect.--Hansens (201).

Two formulas for DDT emulsion concentrates and detailed instructions for spraying houses for the control of malaria mosquitoes are given. The summer formula contains 35 percent of DDT in xylene and Triton X-100 and the winter formula 20 percent of DDT. For use these concentrates are mixed with water in the ratio of 1:13 and 1:7, respectively, to give a spray containing 25 mg. of DDT per milliliter.

An application of 4 ml. of this spray per square foot remains effective for 3 to 5 months.--U. S. Public Health Service (354).

A 3-percent DDT dust had little effect against adults but as little as 0.5 percent of DDT in kerosene kept tents free of adults for the 3 1/2-week test period. DDT-oil emulsion destroyed the original mosquito population in the treated area, but mosquitoes coming into the area were able to bite. Therefore, DDT is not efficient for temporary outdoor protection. Field and laboratory tests were made against larvae of Culex pipiens, Aedes sollicitans, and Anopheles quadrimaculatus with dusts, emulsions, alcoholic colloidal dispersions, and kerosene solutions. The dust diluents used were talc and pyrophyllite. The most used emulsion (50-D) contained 66 percent of kerosene, 2 percent of DDT, 0.5 percent of sodium lauryl sulfate, and the rest water, and was diluted 1 to 10 with water for field application. --N. J. Agr. Expt. Sta. (275).

A new device for mosquito extermination consists of a bottle containing a small amount of DDT in oil, which is partly buried in the soil where hatching is likely. The bottle has an opening just above ground level. When the flood water arises to this opening, the oil floats out and spreads a thin, deadly film to kill newly hatched mosquitoes as they come to the surface.--Stenerson (337).

Tests against adults were made in a Peet-Grady chamber using 6 ml. of spray and a 2 1/2-minute exposure. The laboratory tests showed that 1 percent of DDT in deodorized kerosene gave only a 57 percent knock-down but a 24-hour mortality of 100 percent. A 1-percent Pyrethrol 20 spray gave excellent knock-down (97 percent) and kill (94 percent). One percent of a 20-percent DDT and 80-percent Thanite combination gave results which compared closely with the pyrethrum, namely, 92 percent knock-down and 96 percent kill; whereas the corresponding results for a spray made up of 1 percent of a 40-percent DDT and 60-percent Thanite combination were 86 percent knock-down and 99 percent kill. The poor knock-down produced by DDT alone in the laboratory led the investigators to restrict field tests to combinations of DDT and Thanite, using pyrethrum as a standard spray for comparison. The results obtained from nine replications were as follows: 1.5 percent Pyrethrol 20, 88 percent knock-down and 73 percent kill; 1.5 percent of the 20-percent DDT and 80-percent Thanite combination, 86 percent knock-down and 94 percent kill; 1.5 percent of the 40-percent DDT and 60-percent Thanite combination, 84 percent knock-down and 98 percent kill. Both the DDT-Thanite sprays gave good results, but the 20-80 combination appears to be particularly promising.--Rice et al. (301).

The early history of DDT as a mosquito control agent has been sketched by Stage (330). In laboratory tests a dosage equivalent to only 1 pound of DDT to 250 acres of water surface was completely effective against full-grown larvae of Anopheles quadrimaculatus Say. DDT was toxic as a dust to 62 percent of these larvae when applied at the rate of 0.0001 pound per acre. As a suspension at 0.01 p.p.m., it gave practically 100 percent mortality in 48 hours, being more than 100 times as toxic as phenothiazine. In the field a spectacular kill of mosquito larvae was observed when a mist spray containing 9.5 quarts of 5 percent DDT in fuel oil was dispersed from a decontamination cylinder over nearly 2 acres of Pontederia swamp. This application, at the rate of 0.15 pound of DDT per acre, gave perfect control over the entire swamp area; i.e., for a distance of 600 feet from the point of application. Although DDT is stable and long-lasting, certain factors limit the duration of its residual action when it is applied in dusts to water surfaces. Research conducted in unprotected breeding areas showed that wave action, wind, and water movements cause shifting of surface films of DDT dust, with a consequent loss in effect shortly after application. In quiet pools where the vegetation is dense, effective control of anopheline breeding has been obtained for a period of 4 to 8 weeks when DDT dusts have been applied at the rate of 1 to 2 pounds of DDT per acre. Very little progress has been made in determining the action of dusts. Because of its extreme toxicity when taken internally and because of the feeding habits of the larvae, it is presumed that DDT in a dust kills primarily as a stomach poison. Tests with petroleum oil solutions at remarkably low dosages have demonstrated satisfactory control of Anopheles larvae. The effective amount of DDT in petroleum oils is essentially the same as when applied in dust form. As little as 1 quart of oil per acre of water surface gives high kills when reinforced with 5 percent of DDT. In fact, the size of the dosage is limited greatly when DDT is applied with existing spray equipment because of the difficulty of spreading the small volume of larvicide evenly over the water. Flowing water has been successfully treated with DDT by means of drip cans. The usefulness of DDT as a larvicide is not limited to anophelines. It is also very effective against culicine mosquitoes. In suspensions, dosages of 1 p.p.m., or higher, show residual toxicity to species breeding in rain barrels. In field applications suspensions and emulsions of DDT were more generally effective against the fresh-water and salt-marsh culicines than was DDT as a surface application in dusts or oil solution. Dosages as low as 0.05 p.p.m. were effective against Aedes taeniorhynchus Wied., A. sollicitans (Walk.), A. aegypti (L.), Psorophora confinnis L. Arr., P. ciliata F., and Culex quinquefasciatus Say. On the basis of this work, Husman and Longcoy in 1943 designed spray equipment for light planes which dispersed a 5- to 10-percent solution of DDT in fuel

oil at the rate of 2 quarts per acre. Excellent control of adult Aedes taeniorhynchus in densely wooded areas was obtained by this means. Sucoess was also attained in 1943 by the use of a 20-percent DDT solution from exhaust equipment installed on a Cub plane. A. W. Lindquist aided in additional tests conducted by the Army in the Panama Canal Zone in April, 1944, and demonstrated a 98 to 100 percent control of Anopheles albimanus Wied., and Mansonia fasciolata L. Arr., when 2 quarts of a 10-percent DDT solution were applied by a Husman-Longcoy spray unit installed on a Piper Cub plane. Some details of operational planning for the application of DDT residual spray to the interiors of 375,000 houses in 110 endemic malarious counties of 13 southern States this year have been presented. Procedures followed and formula, material, and equipment being used in current operations are preliminary and subject to further refinement and basic alteration as a result of experience gained from routine project operation and field experimental work. The concentrate solution, which is carried by the hand sprayer crew in an Army-type 5-gallon gasoline can, is composed of 35 percent DDT in xylene, plus a small quantity of emulsifier. This solution is readily miscible in water. The emulsion has a breaking time of 30 minutes but this does not occur while the sprayer is agitated as in normal usage. Other comparative advantages of an aqueous emulsion are freedom from fire hazard and reduced solvent action and spotting on interior finishes, clothing, and other fabrics. An emulsion application rate of 4 ml. per square foot will be used. While lower quantities can be applied on experimental activities, experience indicates that most laborers apply at least 4 ml. per square foot to obtain visible wetting of the surface. Under these conditions, a DDT application rate of 100 mg. per square foot dictates the selection of a $2\frac{1}{2}$-percent emulsion strength.--Henderson (206).

DDT insecticides are so much more effective than previous weapons against malaria mosquitoes that for the first time there is a practical hope for eradicating that disease from this country.

"For the control of mosquito larvae DDT as a dust is no more useful than paris green. At present, with a price differential of well over 50 cents a pound, it would seem inadvisable even to experiment with DDT as a dust larvicide. The chief value of the spray is that extremely small quantities may be as effective as the application of large amounts of fuel oil. A 5 percent dilution in kerosene or diesel oil is excellent. The ideal treatment recommended for this dilution is 1 to 2 quarts per acre, as contrasted with 18 to 20 gallons of fuel-oil dispersal. These figures give some idea of the minute quantity that should be used."

"Contrary to reports from some of the earlier experiments however, DDT has no magic power of spreading itself over water surfaces. In dispersing the small amount of material required, one must make sure that it is introduced over the entire surface, particularly if rafts and booms of floatage will cut its access to the sheltered areas where breeding may be intense. In dispersing the 5-percent kerosene mixture, one may well apply the material from the windward side and allow it to drift over the breeding area. In order to increase the coverage and to cut down the care which is necessary in applying minute amounts with kerosene as a carrier, considerable work has been done with emulsions. By using a quick-breaking emulsion, such as is made with phthalic glyceryl alkyd resin, one can apply the material on the acre basis, figuring at the rate of about 1/10 pound of DDT per acre. If, however, a tight emulsion is produced, as with polyethylene emulsifier, the dosage should be figured roughly on a volumetric basis so that the DDT will not exceed 1 part in 10 million. Any greater concentration will certainly be detrimental to fish. The addition of DDT to irrigation water at its source has proved particularly disappointing."

A residual spray applied at the rate of 100 to 200 milligrams per square foot will effectively kill all adult mosquitoes that come to rest on the treated walls for a period of at least 3 months and possibly longer.--Freeborn (160).

Same as Aedes sollicitans.--Ginsburg (178).

DDT is more toxic to mosquito larvae than any agent heretofore known. Consequently, it can be used in small amounts with resultant saving in time and effort. Sprayed on interior surfaces DDT remains as a residue which will kill insects lighting on the treated areas for several months. Thus, by spraying the habitations of native carriers, a long-lasting means is provided to destroy infected mosquitoes which might convey malarial parasites to troops. DDT, just recently available in quantity for mosquito control, is a revolutionary new weapon in the fight against malaria.--Simmons (319).

Anopheles triannulatus (N. and P.)

Same as for Anopheles albimanus.--Gorgas Memorial Laboratory (182).

Anopheles spp.

For the control of adults with residual sprays a dosage of 100 mg. of DDT per square foot should be aimed at. Another promising use of the film effect is the impregnation of wide-meshed bed nets, which would probably make them effective barriers against small species of Anopheles, and also against such little pests as Phlebotomus.

For the control of mosquito larvae a standard dosage for many types of water is 1 to 2 imperial quarts per acre of a 5-percent (w/v) solution of DDT in an oil of good spreading power. It is often very difficult to put down so small a volume on an acre, even using a fine nozzle and low pressure on the sprayer: it may be preferable to double or treble the volume of oil, using the same amount of DDT.--Buxton (100).

DDT is a contact poison to Anopheles.--Domenjoz (135).

The methoxy and the ethoxy analogs of DDT were found about equally effective against mosquito larvae (Culex quinquefasciatus); concentrations of 0.03 to 0.04 p.p.m. in tap water killed half of the larvae in 20 hours. The n-propoxy analog at 0.4 p.p.m. gave about a 50 percent kill while the n-butoxy analog at 4 p.p.m. gave a negligible kill.--Prill et al. (297).

Culex pipiens L., the northern house mosquito

Same as for Aedes sollicitans.--N. J. Agr. Expt. Sta. (275); Ginsburg (178).

Culex salinarius Coq.

Culex territans Walk. (= restuans Theob.)

Same as Aedes sollicitans.--Ginsburg (178), also N. J. Agr. Expt. Sta. (275).

Unidentified mosquitoes

The abundance of unidentified mosquitoes was noticeably reduced in a number of plots sprayed with DDT.--Craighead and Brown (125).

Adult mosquitoes and houseflies were killed by applying a 5-percent DDT solution in kerosene to walls, doors, and screens of buildings by means of power paint sprayers, hand spray guns, and paint brushes. The men wore protective masks. The insecticide did not give immediate results but after several days medical officers were convinced of its effectiveness. Areas have to be resprayed about every month or 6 weeks. --Farr (149); Anon. (19).

A joint statement of policy by the U. S. Army and the U. S. Public Health Service, adopted March 31, 1945, called for the distribution of DDT from aircraft for large-scale area control of mosquitoes in military and adjacent areas in the United States to be limited to projects conducted with due regard to its possible effects on beneficial insects and all forms of plant and animal life, and in accordance with safeguards

established by the Surgeons General of the two services.--U. S. Army and U. S. P. H. S. (351).

The use of DDT by troops during an invasion to control mosquitoes, flies, and other insect vectors of diseases is discussed.--Logue and O'Connell (248).

Kaolin containing 1 percent of DDT was dusted on sheets of paper on which mosquitoes were separately placed and covered with a beaker. The time, in minutes, to partial paralysis was 20, to total paralysis 60 to 70, and to death 170-190. When 1 percent of DDT in kerosene-tung oil mixture was spread on water it killed mosquito larvae in 40 to 50 minutes.--Sen (311).

Itonididae

Aphidoletes sp.

Cucumbers heavily infested with aphids were sprayed with 16 ounces of DDT per 100 imperial gallons of water, both in powder suspension and in Velsicol emulsion, and counts showed no apparent reduction in the large numbers of Aphidoletes larvae present.--Ross (306).

Diarthronomyia hypogaea (Loew), the chrysanthemum gall midge

Several hundred cuttings of 15 to 20 varieties and small plots of 2 varieties were sprayed. Cuttings were sprayed twice at 10-day intervals and plants were sprayed four times at 5- to 7-day intervals. The spray contained 5 pounds of a 20 percent DDT-pyrophyllite dust plus 0.5 percent Vatsol OS in 100 gallons. On cuttings after treatment, 0.64 new gall per plant appeared as compared with 24.2 galls on untreated plants. Larvae and pupae in galls were not affected and newly emerged adults lived long enough to lay eggs. On newly set plants excellent control was obtained and no plant injury was apparent after 10 weeks. --N. J. Agr. Expt. Sta. (275).

Monarthropalpus buxi (Lab.), the boxwood leaf miner

This pest was readily controlled with DDT (0.1 to 1 percent) applied as an emulsion in small-scale tests.--Craighead and Brown (125).

Muscidae

Glossina spp.

Glossina spp. are readily killed by traces of DDT on cloth. This opens up great possibilities of control, by treating bait animals with

DDT emulsions, or by impregnating clothing or sacking screens.--Buxton (100).

Musca domestica L., the housefly

A 2-percent solution of DDT in deodorized kerosene sprayed on the walls and ceiling of a poultry killing room gave 100-percent mortality of flies in the room up to a month after treatment. Over a 6-week period only 8 percent as many flies were observed within a poultry laying house, the walls and ceiling of which had been sprayed with a 3-percent solution of DDT in deodorized kerosene, as were seen in an unsprayed house.--Wolfenbarger et al. (379).

See also under Themira putris.--Wolfenbarger et al. (379).

See Anopheles spp.--Farr (149); Anon. (19).

In one test a 0.01-percent solution of Gammexane killed 73 percent of a known number of flies, whereas a 0.02-percent DDT solution killed only 51 percent.--Anon. (52).

DDT may be sprayed over wide areas from the air. In Sweden farm and grain areas have been treated this way throughout the year at intervals of several months and dairy farms have been practically fly-free during the entire summer. Increase in milk production was noted. In the future there may be derived an effective insecticide from the combination of pyrethrum (or derris) and DDT, in which the pyrethrum will have the rapid and the DDT the lethal action.--Ahlberg and Mathlein (69).

Unpublished figures by Parkin and Green of the Department of Scientific and Industrial Research [Great Britain] show that 0.05 percent of DDT plus 0.02 percent of pyrethrins is barely satisfactory against flies. A mixture containing 0.10 percent of DDT and 0.03 percent of pyrethrins, applied with hand sprayers at the rate of 25 cc. per 1,000 cubic feet in rooms and army huts at about 24°C. gave a high knock-down and killed all the flies. These workers have also shown that mixtures of DDT and pyrethrum in kerosene can be stored under suitable conditions for at least 17 months at 27.5°C. without marked deterioration. The present British official recommendation for a general spray for killing adult flies and mosquitoes is 0.07 percent pyrethrins (or more if available); or 0.05 percent pyrethrins + 0.3 percent DDT; or 0.03 percent pyrethrins + 0.5 percent DDT. The percentage of DDT refers to the pure para-para-prime substance. The dosage is 10 cc. per 1,000 cubic feet (1 fluid ounce per 3,000 cubic feet), subject to considerable latitude, if used in rather open huts. --Buxton (100).

We can anticipate the use of DDT sprays on walls and screens for gradual reductions of fly populations. If some formulations of such sprays are used on animals, they may be found rather slow in killing stable flies, horse flies, and deer flies. These kinds of flies may bite and fill with blood before they die from the effects of the sprays. For these important kinds of flies there would seem to be an opportunity for including in the new sprays a repellent that would drive away the flies during milking or for longer periods of time. Again, this involves more research if we are to get the correct answer. If repellents are used in spray mixtures, will they drive away the insects during the period when the fly toxicant is most effective, thereby reducing the efficiency of a spray as a killer of horn flies and other flies on cattle?--Dove (137).

According to the U. S. Army Medical Department the DDT insecticides suitable for use in fly control are: (1) Insecticide, spray, DDT residual effect (5 percent DDT in kerosene), Quartermaster Stock No. 51-I-305; (2) insecticide, powder, louse (10 percent DDT in pyrophyllite), Quartermaster Stock No. 51-I-180; (3) larvicide, DDT, powder, dusting (10 percent DDT in talc), Quartermaster Stock No. 51-L-122. Use the DDT insecticides as follows in pit latrines: Apply the spray at the rate of 1 quart for approximately 250 square feet to the walls of the pit, inside and outside the latrine box, and to all the walls, window screens, and screen doors of the enclosure. One application usually is sufficient for several months. Apply DDT residual spray at the rate of 2 ounces per latrine box hole, or 10-percent DDT powder at the rate of 1 ounce per hole to the pit contents. Apply twice weekly until experience reveals how often application need be repeated. Residual spray may also have a place in the field for treating ration dumps and dead bodies to control fly breeding. As little as 0.025 percent of DDT in oil has been found effective in killing maggots breeding in meat. The residual spray should kill both adult flies and larvae. Since the odor at times may be offensive, work is under way to find a satisfactory deodorant to incorporate in spray for this purpose.--Anon. (26).

For the control of houseflies and stableflies apply DDT exactly as for residual spraying for mosquitoes. The spraying of manure piles, the walls behind them, and the most obvious gathering places in the stables will destroy numerous flies before they leave the breeding grounds. For household control treat especially screens, door and window frames, shelves, the edges of pillars, and other areas that fly "specks" indicate as habitual resting places.--Freeborn (160).

When tested by the method described under Rhodnius sp. the lethal dose of pure DDT to adult Musca domestica was 1.0 mg. per square centimeter of surface.--Buxton (100).

When DDT was sprayed in barns of the Idaho Agricultural Experiment Station in September, the air was full of flies. In October when flies should have been their worst, the barns were as fly-free as they usually are in midwinter. The DDT was applied as a light spray, of about 1 percent strength, to walls, ceilings, doors, and windows.--Idaho Univ. Col. Agr. (221).

The methoxy, ethoxy, n-propoxy, and n-butoxy analogs of DDT were toxic to houseflies in diminishing degree in the order named. The methoxy analog excels DDT in knock-down but does not equal it in kill. --Prill et al. (297).

DDT percentages evidently are not being increased in the aerosol, and Army authorities continued to depend on pyrethrum as the knock-down ingredient in fly and mosquito repellents, with sesame oil as the synergist and Freon-12 gas as the carrier. Yet DDT has been shown to increase the effectiveness of the formula considerably.--Stenerson (336).

In kerosene solution, varatridine was more toxic than cevadine to houseflies, and both these constituents of sabadilla were more toxic than DDT.--AIF (66).

Two days after the initial assault in Iwo Jima in the Pacific the island was sprayed with a DDT solution by airplane. In spite of the thousands of American dead and Japanese corpses on the island, the fly problem which was so great in former Pacific amphibious operations was practically nil.--Peaker (291).

A report of tests of a DDT-oil fog in the Salt River Valley, Ariz. The oil solution of DDT is not burned but made into a fog by feeding into a current of steam. Some of the cattle were driven through a canvas-covered chute, with the generator blowing fog over them. Some were simply enveloped in fog as they stood in an open corral. A blast was also turned into the barn. Almost at once lifeless hornflies and houseflies began to roll off the backs of the cattle. Flies rained down upon the floor of the barn and continued to fall for two days. For 2 days, also, the "fogged" cattle remained free of flies. Dr. Dietz said that from his experiments the residual effect of DDT lasts for 14 days in the open air when application is by spray. Apparently the time is less when application is by fog, probably because the amount deposited is so much less.--Anon. (49).

A water suspension of DDT gave excellent control of flies in a dairy barn. One of the mixtures tested was, DDT (AK-20, containing 20 percent DDT) 10 pounds, blood albumin 6 ounces, water 100 gallons.--Michelbacher et al. (258).

A water suspension of DDT (1 pound per 100 gallons) is preferred for the control of flies in dairy barns because of the danger of the operator becoming thoroughly wet with a kerosene solution and hence poisoned when it is necessary to spray overhead.--Michelbacher (256).

A 10 percent DDT-pyrophyllite dust was applied in a dairy barn about 3 p.m. on July 25 by means of a hand duster; this was directly after the cattle had been brought in from out-of-doors. Immediately prior to application the floors were swept clean and most of the windows closed. Within 15 to 20 minutes the flies were observed dropping to the floor, and by 4 p.m., which was milking time, no fly spray was needed before the cows could be milked. Approximately 3 to 4 flies per square foot of floor surface were killed the first day after the dusting, but the number rapidly diminished thereafter. On the third day the herdsman found it necessary to resume the application of a fly spray. A spray made by adding a 25 percent DDT self-emulsifying concentrate to water (1:160) plus 1.4 pounds of blue vitriol per 100 gallons greatly reduced the number of flies in a hog barn.--Munro et al. (271).

A small unscreened compartment containing a bull was sprayed with 3 percent DDT in kerosene. One hour after spraying all flies were dead or affected and for 9 days thereafter fly annoyance was at a minimum. A small unscreened stable was sprayed several times with 1.5 to 3 percent DDT in kerosene. A manure pile adjacent to the stable served as a constant source of reinfestation. Flies were eliminated from the stable for 1 day after treatment. They were present thereafter in about the same numbers as before spraying. Three percent DDT in kerosene gave control of flies in chicken coops for about 3 weeks. In other tests 3 percent DDT in kerosene sprayed on the outside of the kitchen at the Merchant Marine rest home failed to give relief. Spraying the inside of a dairy barn feed house where flies congregated with 3 percent DDT in kerosene gave unsatisfactory control.--N. J. Agr. Expt. Sta. (275).

Two methods were used to control flies in barns in Minnesota. In one test all the screens were painted with 5 percent of DDT in kerosene. In the other tests water suspensions of Neocid A-5 or Neocid A-20 were sprayed on the walls and ceiling. Painting the screens killed large numbers of houseflies and stableflies, but the amount of surface treated was too small to give satisfactory control. It was estimated that the population was reduced by 30-40 percent after the screens were treated. A water suspension of 2 percent of Neocid A-5 gave fair control for about 1 month when applied to walls and ceiling as a coarse spray. Both a 1-percent and a 2-percent suspension of Neocid A-20 gave much better control, with the latter giving good results for 6-8 weeks. One barn with about 5,000 square feet of sprayed surface was kept free

of flies all summer with two applications of 18 gallons each of a 2-percent suspension of Neocid A-20.--Hodson (212).

Adult houseflies of both sexes, 5 days old, were sprayed under regular Peet-Grady test conditions with 0.2 percent of DDT in Deobase. DDT caused slight dissolution of fiber tracts and degeneration of nuclei both in the brain and in the fused thoracic ganglia, but in spite of its pronounced neurologic symptoms histological changes were relatively slight.--Hartzell (202).

Five percent of DDT in kerosene painted on a fly screen killed flies for more than 6 weeks. Where the sun shines on the screen it will last for 2 or 3 weeks.--Hutson (220).

DDT is a contact poison to Musca domestica.--Domenjoz (135).

Preliminary tests were made of DDT in a solvent composed of 90 percent acetone and 10 percent Deobase by applying the spray directly to screen cages containing the flies. From the dosage-mortality curve so obtained, it was found that dilutions as low as 0.025 percent were quite effective against flies with regard to kill but were slow in knockdown. Sprays ranging from 5 percent to 0.2 percent of DDT gave complete knockdown in from 11 to 15 minutes. It was clear that DDT was slow in knockdown and that its knockdown could not be increased materially by an increase in concentration of the DDT. On the basis of these results, three Deobase sprays were made up containing 0.2 percent of DDT to give a safe margin for practical use. Each spray contained a different paralytic agent to evaluate three common agents now on the market. Butyl carbitol thiocyanate was used at 0.75, bornyl thiocyanoacetate at 1.2, and pyrethrins at 0.05 g. per 100 ml. of spray. These sprays were evaluated in the Peet-Grady chamber and in laboratory rooms in which 300-500 flies had been liberated. The sprays were found to be almost equally effective, killing all the flies overnight. In the practical tests in rooms, knockdown required about 30 minutes, probably because of the high ceiling in the rooms used. Knockdown in the Peet-Grady chamber was very satisfactory in each case. A Deobase spray containing 0.2 percent of DDT was atomized into a Peet-Grady chamber at the rate of a fluid ounce per 1,000 cubic feet. Sheets of cellophane and cotton towels were placed on the floor of the chamber to catch the falling residue, and, after all the spray had settled out, the cellophane towels were removed and placed in glass cages containing about 100 flies each. The residue from a single spraying on cellophane (0.33 mg. per sq. ft.) killed 74 percent of the flies confined with it for 24 hours. Sheets held for 7 days before exposure to flies killed only 1 percent of the insects. The residue from three sprayings (1 mg. per sq. ft.) killed 100 percent and 88 percent of the

flies in the 1- and 7-day intervals after spraying. Six spray applications (2 mg. per sq. ft.) produced a residue killing all flies even after the 7-day interval. From these results it is quite evident that fly sprays containing 0.2 percent of DDT will leave a toxic residue when they settle out on nonabsorbent surfaces near or on the floor of a room. Spray residues on cotton towels were much less effective against flies. Six spray applications (2 mg. per sq. ft.) killed only 46 percent of the flies confined on the towels within the first day after spraying. Eighteen application (6 mg. per sq. ft.) killed 92 percent of the flies on immediate exposure and 89 percent 7 days after the spray was applied. These figures show that several applications of a fly spray containing DDT in a room will leave a toxic residue on nonporous surfaces on which it settles, but that toxic residues will not be built up on porous materials such as carpets, bedspreads, etc. Several different types of DDT formulations were applied to nonabsorbent surfaces to check the type of residue likely to be most effective against houseflies. In order of their effectiveness, these compositions were a DDT solution in a nondrying oil, a 5-percent dust (talc), an aqueous suspension of a wettable powder, a solution in acetone, and a 5-percent solution in paste wax. The results seem to indicate that residues are effective in proportion to their ease of removal or low adhesivity to surfaces.--Goddin and Swingle (179).

One percent of DDT in kaolin was dusted on sheets of paper on which insects were placed separately and covered with a beaker. The time in minutes, to partial paralysis was 6, to total paralysis 20, and to death 150-160.--Sen (311).

The effect of a residual deposit of DDT on flies was investigated under practical conditions at the Central Experimental Farm, Ottawa, from September 7 to November 14, 1944. GNB-A-DDT (commercially pure DDT) was dissolved in a small quantity of benzene and diluted to 5, 4 and 3 percent with deodorized kerosene. Walls and ceilings were sprayed in (a) a milk room with 5 percent spray, (b) a dairy building with 4 percent, (c) a calf barn with 3 percent, and (d) a piggery with 3 percent. Control during the period of almost 10 weeks averaged 99 percent in the dairy, 96 percent in the piggery, 92 percent in the milk room, and 88 percent in the calf barn. The daily kill at one time reached approximately 30,000 in the piggery. The tests were terminated by cold weather. Flies killed included Musca domestica L., Stomoxys calcitrans L., Fannia canicularis L., Lucilia caesar L., Muscina stabulans Fall., and a few other species in small numbers.--Ross (306).

Muscina stabulans (Fall.), the false stablefly

Same as for Musca domestica.--Ross (306).

Siphona irritans (L.), the hornfly

See Musca domestica.--Anon. (49); Munro et al. (271).

Stomoxys calcitrans (L.), the stablefly

An open milk shed, including the floor, was dusted thoroughly with a 3-percent DDT dust on September 18 and again 3 days later. Before dusting the flies were so numerous it was almost impossible to milk the cows as both cows and milkers were severely attacked. Three days after the second application only an occasional fly was observed. The legs of the cows were also dusted with the 3-percent dust without any observable harmful effect.--Ewart (145).

See Musca domestica.--Dove (137); Freeborn (160); Munro et al. (271); N. J. Agr. Expt. Sta. (275); Ross (306).

Stomoxys spp.

An extraordinary reduction of Stomoxys, in West Africa, followed the spraying of one cow out of a small herd of a dozen animals which were suffering very greatly.--Buxton (100).

Oestridae

Hypoderma bovis (Deg.), the northern cattle grub

Gesarol A spray 7.8 pounds (DDT 0.4 pound) per 100 imperial gallons of water sprayed on animals at 400 pounds pressure had little effect on warbles, killing only 5.5 percent as compared with 73.9 percent by a 5-percent rotenone mix at 250 pounds' pressure.--Ross (306).

DDT is a contact poison.--Domenjoz (135).

H. lineatum (De Vill.), the common cattle grub

Same as for H. bovis.--Ross (306).

Psilidae

Psila rosae (F.), the carrot rust fly

In Switzerland the injury caused by the first generation of the carrot fly can be controlled by watering the carrot crop in mid-May with a 0.5 to 1.0 percent Guesapon emulsion at 4 liters per square meter. The control of the more serious second-generation injury can be achieved by watering the crop with 2 percent Guesapon at 4 liters per square meter in mid-July.--Geigy Colour Co. (166).

Gesarol A-3 (3 percent DDT) was dusted on the crowns of the plants at the rate of 1/2 pound per 100 feet of row. Three applications on July 13, 21, and 28, were made and the crop was lifted September 1. Little or no control resulted, the infestation being 29 percent in the

check and 24 percent for the Gesarol A-3 dust.--Ross (306).

One application of Gesarol A-3 dust at the rate of 0.5 pound per 100-foot row reduced the percentage of wormy carrots from 55 (in the check) to 12.--Morrison (266).

Sepsidae

Themira putris (L.)

Samples containing 1/14 cubic foot of maggot-infested poultry droppings treated with 1-percent solutions or suspensions of phenothiazine, DDT (Gesarol A-20), thiourea, and borax, yielded, respectively, 26, 28, 83, and 89 adult flies, whereas the corresponding number for the check was 238. Solutions or suspensions containing 0.3, 1.0, and 5.0 percent of the toxicants were used to treat similar samples of droppings. The average numbers of flies which emerged per sample from droppings treated with these three concentrations were as follows: Phenothiazine 23, 5, and 5; DDT oil solution, 9, 3, 0; DDT water suspension, 3, 30, and 19. Areas under turkey sun porches were treated with phenothiazine diluted 1:5 with lime, and 1-percent spray solutions or suspensions of borax, DDT (Gesarol A-20), and thiourea. The average numbers of flies emerging per sample were 21, 18, 21, and 37, whereas 87 emerged from the control.--Wolfenbarger et al. (379).

Simuliidae

Simulium spp., black flies

The abundance of black flies was noticeably reduced in plots sprayed with DDT.--Craighead and Brown (125).

Syrphidae

Sphaerophoria cylindrica (Say)

In laboratory tests there were no survivors in any DDT-treated cages after 24 hours. The DDT (Gesarol A-20) was added to water at the rate of 0.8 pound in 100 gallons. The test plant was plum foliage infested with aphids.--Fluke and Pond (157).

Unidentified species

Syrphid flies, eggs, and larvae were extremely abundant and active on rosy apple aphid colonies on opening buds in an untreated plot but were not apparent in a DDT-treated plot.--Cleveland (114).

There appeared to be no appreciable mortality of syrphid larvae on aphid-infested cucumbers thoroughly sprayed with 16 ounces of DDT per 100 imperial gallons of water in powder suspension or Velsicol emulsion.--Ross (306).

Tabanidae

Chrysops flavida Wied.

Same as for Tabanus abactor.--Okla. Agr. Expt. Sta. (278).

Chrysops spp., deer flies

The abundance of deer flies was noticeably reduced in a number of plots sprayed with DDT.--Craighead and Brown (125).

See Musca domestica.--Dove (137).

Pangonia incisa Wied. (= Esenbeckia incisuralis (Say))

Same as for Tabanus abactor.--Okla. Agr. Expt. Sta. (278).

Tabanus abactor Philip

T. equalis Hine

T. gracilis Wied.

T. lineola F.

Aqueous sprays containing 5 percent of DDT applied to cattle gave repellency while wet. The flies began to die in 12 to 18 hours after feeding but much of the spray's effectiveness was lost after 24 hours. Definite conclusions were not made due to high mortality in the checks. --Okla. Agr. Expt. Sta. (278).

See Musca domestica.--Dove (137).

Tachinidae

Spilographa electa (= Zonosemata electa (Say)), pepper maggot

A 3-percent DDT dust and a spray containing 1 pound of DDT in 100 gallons of water were applied to peppers four times at weekly intervals after the first egg punctures were noted. The spray gave a reduction of 45 percent in infested peppers and the dust gave 25 percent reduction. Adults were noted walking over the insecticide deposit, but no dead flies were found in the plots.--N. J. Agr. Expt. Sta. (275).

Trypetidae

Rhagoletis cerasi (L.), the cherry fruitfly

Field experiments carried out in Switzerland in 1943, showed that it is possible by correct, biologically based spraying of cherry trees with 1 percent of Gesarol to combat this insect successfully even in highly infested areas. The spraying of the cherry trees should begin during the first days of June. A second treatment applied 14 to 16 days after the first will last until harvest. No separate treatment of the ground is necessary.--Wiesmann and Fenjves (375).

Rhagoletis cingulata (Loew), the cherry fruitfly

Rhagoletis fausta (O.S.), the black cherry fruitfly

Results obtained with DDT against the cherry fruitfly were promising enough to warrant further tests.--Baker and Porter (81).

Results of tests with DDT in Oregon in 1944 for the control of the cherry fruitfly were far from favorable.--Childs (110).

Dusts containing 2 or 3 percent of DDT with sulfur, talc, and diatomaceous earth at 40 pounds per acre failed to give satisfactory control of the cherry fruitfly.--Childs and Robinson (111).

In the laboratory the action of several DDT preparations on flies was slow, although some of the flies showed typical DDT symptoms within an hour after they were put in the cages. It required 80 or more hours to kill 50 percent of them. Two field plots received one application of 2 percent and 3 percent dust respectively, combined with 50 percent sulfur and talc. One application of these dusts at 40 pounds per acre was not effective.--Jones (230, 232).

Rhagoletis pomonella (Walsh), the apple maggot, the blueberry maggot

Results obtained with DDT were promising enough to warrant further tests.--Baker and Porter (81).

Four applications of emulsive summer oil containing DDT, used to give about 2 ounces of DDT per 100 gallons of spray, and timed to cover the period of first-brood attack, gave a considerable degree of control and a long lasting residual effect against second-brood infestation.--Cleveland (114).

In tests made in New Hamphsire apple orchards during 1944 Gesarol AK-20 spray was superior to lead arsenate.--Conklin (116).

In laboratory tests DDT (in acetone suspension) at 1 pound per 100 imperial gallons of water gave poor results as a residual poison on fruit. No flies were killed within 24 hours, and some were still living after 14 days. Two sprays of calcium arsenate in bordeaux (10-10-100) gave better control than two applications of Gesarol A-3 dust (3 percent DDT) in a field test on blueberries in New Brunswick.--Ross (306).

A plot of 43 trees in an old apple orchard was dusted three times with Gesarol A-3 dust (3 percent DDT). At harvesttime, 97 percent of the dusted apples and 100 percent of the check apples were stung. There were 8.68 stings per dusted apple and 25.92 stings per check apple, a reduction of 86.5 percent on the dusted plot.--Lathrop (244).

Miscellaneous Diptera

Examination of the ground under hairy vetch at Oregon City, Oreg., disclosed that 5-percent DDT dust had killed agromyzids and scatophagids. Syrphid larvae, which were abundant, appeared to be unaffected.--Rockwood and Reeher (303).

Solutions of 1.2 and 2.4 percent of DDT in oil seemed to have an effect in reducing populations of a predaceous fly Thamatomyia glabra (Meigen), and parasites of the genus Solenotus (parasites on larvae of the pea leaf miner), all on peas. No apparent effect was obtained on chalcid parasites of the pea leaf miner.--Lange (241).

SIPHONAPTERA

Pulicidae

Ctenocephalides canis (Curt.), the dog flea

Fleas on short- and long-haired dogs were controlled with Neocid A-5 and A-10.--Parker (287).

DDT is a contact poison.--Domenjoz (135).

A 10-percent DDT dust controlled fleas on dogs.--Haseman (203).

Ctenocephalides felis (Bouché), the cat flea

Cat and dog fleas in the basements of houses have been destroyed with 3 percent DDT in pyrophyllite applied at 2 ounces per 100 square feet.--N. J. Agr. Expt. Sta. (275).

Pulex irritans L., the human flea

DDT is a contact poison.--Domenjoz (135).

Xenopsylla cheopis (Rotsch.), the oriental rat flea

Chicken houses which were in bad condition and contained much litter were heavily infested with rat fleas. The farm was heavily infested with rats. One-fourth pound of 3 percent DDT in pyrophyllite per 100 square feet failed to give results. Repeat tests using 5-percent DDT dust gave satisfactory results. A heavy infestation of fleas in a building in good condition was treated with 1/4 pound of 5 percent DDT in talc per 100 square feet. There were very few rats present. Control of fleas was excellent.--N. J. Agr. Expt. Sta. (275).

Unidentified fleas

A 10-percent DDT dust rubbed into the fur of pets constitutes a satisfactory primary source of control. A 5-percent kerosene spray applied to floors, chicken houses and yards, dog kennels, and stable floors is extremely effective. Persons have gained relief from flea bites by treating the underclothes with a 10-percent DDT dust in talc.--Freeborn (160).

At Clemson, S. C., two basements heavily infested with fleas which were spreading up into the house were dusted with a 3-percent DDT dust and complete relief was obtained by the following day.--Cartwright (108).

A 1-percent DDT-kaolin powder was dusted on sheets of paper on which fleas were separately placed and covered with a beaker. Fleas were partially paralyzed in 11 minutes, totally paralyzed in 40 to 50 minutes, and killed in 700 to 740 minutes.--Sen (311).

SCORPIONIDA

Centruroides limpidus limpidus Karsch

Young scorpions just after the first molt are easily killed in 24 hours by a 10-percent DDT powder, and also by a film of DDT on an ordinary filter paper. The adults of the same species are dead before 72 hours in technical DDT. When exposed to treated filter paper, most of the adults die about the tenth day.--Vargas and Colorado Iris (360).

ARANEIDA

Latrodectus mactans (F.), the black widow spider

Not affected during 6 days by a deposit of DDT on filter paper.--Vargas and Colorado Iris (360).

Unidentified spiders

Examination of the ground under hairy vetch at Oregon City, Oreg., disclosed that 5-percent DDT dust had killed spiders.--Rockwood and Reeher (303).

ACARINA

Eriophyidae

The pear bud mite

Six large trees in a Comice pear orchard heavily infested with pear bud mites were sprayed with a mixture of 5 pounds of AK-20 (20 percent DDT) and 4 ounces of sodium oleyl sulfate in 100 gallons of water. A population count made a week later showed no apparent kill of the mites.--Borden and Jeppson (92).

Ixodidae

Dermacentor andersoni Stiles, spotted-fever tick

In preliminary tests DDT was of little value in controlling this species of tick. A yearling beef sprayed along the back with Gesarol A spray 50 pounds (DDT 2.5 pounds) per 100 gallons of water did not appear to be resistant to ticks placed on the animal 1 week later. Similar results were obtained on rabbits infested 3 days after treatment with Gesarol A dust, or a spray of Neocid No. 15.--Ross (306).

Ornithodoros nicollei Mooser

Ornithodoros turicata (Duges)

A low percentage of DDT on filter paper killed adults within 2 weeks. By the eighth day they were unable to bite a guinea pig.--Vargas and Colorado Iris (360).

Rhipicephalus sanguineus (Latr.), the brown dog tick

DDT is superior to anything yet found for the control of the brown dog tick.--Anon. (15).

A local veterinarian reported that all ticks dusted with DDT died within 48 hours, whereas ticks which dropped from the dog when treated with a pyrethrum dip recovered and lived as long as 42 days.--Cartwright (108).

This tick proved difficult to control with Neocid A-5 and A-10. Approximately 50 percent of these ticks on the dogs and about the premises of the dog owners were destroyed.--Parker (287).

Sarcoptidae

Knemidokoptes gallinae (Raill.), the depluming mite

Chickens badly infested with this mite and the hen house were dusted with a 5-percent DDT dust. After 2 weeks the treated chickens were

almost completely free from the mites and began to put on new feathers. The second application completely rid the birds of the pest.--Granovsky (187).

Sarcoptes scabiei (Deg.)

Against human scabies DDT is surprisingly inefficient. A saturated solution in oil, or an emulsion in water applied to the skin, kills less than 50 percent of the Sarcoptes in 24 hours, whereas benzyl benzoate emulsion or sulfur ointment will kill well over 99 percent. DDT is certainly not to be recommended for the treatment of scabies.--Buxton (100).

Sarcoptes suis Gerlach

DDT in aqueous suspension did not control sarcoptic mange on pigs. --Shull et al. (315).

Notoedres muris (Megnin), notoedric mange on rats

A 1-percent solution of DDT in liquid paraffin or olive oil had very little effect. A 2-percent solution led to the death of some of the experimental rats after the development of marked hyperaesthesia and frequent clonic muscular spasms.--Taylor (343, 344).

Tetranychidae

Paratetranychus citri (McG.), the citrus red mite

DDT apparently is not toxic to this mite at the dosages required for codling moth control.--Baker and Porter (81).

In all orchards in which DDT was used there was an increase in the citrus red mite population, and in an orchard in Buena Park, Calif., the citrus aphids, as well as the citrus red mites, became serious pests, whereas neither were of any commercial importance in plots where oil only was used. Where DDT was used with kerosene, or as an aqueous suspension of powdered solids, or in dust form there was a greater increase in the mite population than where it was used in regular spray oil.--Ebeling (142).

Paratetranychus pilosus (C. and F.), the European red mite

Destructive increases in mite population at Vincennes, Ind., did not occur in plots in which low dosages of DDT (4 ounces per 100 gallons) were used, but they did occur in most plots in which higher ones were used. At the dosages required for codling moth control, DDT seems not to be toxic to this species. The use of DDT has in several cases caused an increase in mite population, apparently by eliminating or reducing the numbers of natural enemies of mites.--Baker and Porter (81).

DDT had little or no direct effect on this mite, but by its drastic action on the mite's enemies, it encouraged outbreaks of this mite in the plots sprayed with DDT for codling moth control.--Ross (306).

Dormant miscible oil containing 5.12 ounces of DDT per 100 gallons controlled the hatching and development of this mite to some degree as compared with untreated checks, but was definitely inferior to a tar-petroleum blend miscible oil. Applied as a summer spray, 2 ounces of DDT per 100 gallons when used with emulsive summer oil at 3 quarts per 100, did not appear to permit build up of initially strong mite infestation, as DDT seems to have done when used without oil. The effectiveness of summer oil did not seem to be noticeably impaired by DDT.--Cleveland (114).

In the 1944 season in New Hampshire complete control of the European red mite on apples was obtained with a delayed dormant application of 1 gallon of Niagara No. 6 dormant oil plus 2 pounds of Gesarol AK-20 to each 100 gallons' of spray. This compared favorably with the recommended spray of 3 gallons of oil to 100 gallons. However, since none of the plots received an application of 1-percent oil alone, one cannot conclude that the DDT was actually responsible for the degree of control obtained. --Conklin (116).

Development of mites was conspicuous on the foliage of all trees sprayed with DDT in codling moth experiments. Bronzing of leaves was much in evidence.--Hough (217, 218).

DDT was absolutely no good.--Hutson (220).

At certain dosages in the range required for effective codling moth control DDT is very toxic to important predators of the European red mite and common red spider. Under favorable weather conditions mite populations have built up in record breaking time in DDT-sprayed plots to extremely destructive levels.--Steiner et al. (334).

Tetranychus atlanticus McG., a red spider

There was no apparent control on small cotton plants lightly infested and dusted with a 3-percent DDT dust (A-3) at the rate of 25 to 30 pounds per acre.--Smith (324).

Tetranychus bimaculatus Harvey, the two-spotted mite

Two-spotted mites increased in numbers when treated with eight applications of 5 percent DDT in light summer spray oil — average about 1/2 gallon per acre — made by hand atomizer from June 6 to August 1.— Gray (188).

A heavy infestation of mites (the brown almond mite and the two-spotted mite) built up in three almond trees that were sprayed with 1 pound of DDT per 100 gallons of water, which soon evidenced severe injury. As the season progressed, the trees immediately adjacent to the DDT-treated trees showed an increase in the mite population--unquestionably because of migration from the three sprayed trees. The sprayed trees finally suffered complete defoliation, whereas those in the main portion of the orchard retained their leaves.--Swanson and Michelbacher (340).

Tetranychus pacificus McG., the Pacific mite

At the dosages required for codling moth control, DDT apparently is not toxic.--Baker and Porter (81).

Tetranychus schoenei McG.

Same as Paratetranychus pilosus.--Hough (217, 218).

Tetranychus willamettei (McGregor), the Willamette mite

At Hood River, Oreg., during September, a noticeable increase of mites occurred on DDT-sprayed trees. The infestation caused noticeable yellowing of leaves, particularly on the lower inside areas of the trees.--Childs and Robinson (111).

Tetranychus spp., common red spiders

A 3-percent DDT dust was ineffective.--Haseman (203).

Greenhouse tests: DDT applied at rates of 1 pound per 100 imperial gallons of water and higher, both powder suspensions and in Velsicol emulsion, has shown no apparent effect on this mite.--Ross (306).

Red spider seriously damaged bean plots treated with a 3 percent DDT dust or a spray containing 1 pound of DDT in 100 gallons of water. --N. J. Agr. Expt. Sta. (275).

In a Bartlett pear orchard in the Sacramento River area of California red spider injury appeared earlier and was more severe in DDT-treated plots than in the remainder of the orchard receiving the regular program of lead arsenate and dinitro.--Borden and Jeppson (91).

A heavy application of Gesarol A-3 dust to cantaloup in a greenhouse was ineffective against red spiders and severely burned the leaves.--Ewart (145).

In tests on eggplant in Nebraska red spider mites began to show up on the DDT-treated plots late in the season and they soon increased to

such an extent that the plants turned yellow and died prematurely. Only slight and insignificant populations developed on the cryolite-treated plants and still fewer on the untreated plots. Before the mite population began to develop, however, DDT-treated plants appeared to have a healthier, greener color than the other plants.--Tate et al. (342).

A 3-percent DDT dust was not effective in controlling red spiders on strawberries.--Walker (366).

Mites on guayule were readily controlled with emulsions containing 0.15 to 0.3 percent of DDT.--Craighead and Brown (125).

Bartlett pear trees developed a rather heavy infestation of spider mite with considerable foliage injury showing at the time of the fifth cover spray. The injury appeared just as severe in the DDT plots as in the lead arsenate plots. An application of DN-111 was made the day following the fifth cover. Good control of the mites resulted and no injury followed.--Childs and Robinson (111).

On apple and peach trees sprayed with DDT for control of the codling moth and the oriental fruit moth there was a tendency toward a build-up of red mites, and in some cases it was serious enough to require special sprays.--N. J. Agr. Expt. Sta. (275).

In plots at Tallulah, La., and Brownsville, Tex., dusted with DDT red spiders were increased somewhat by the treatment but did not become sufficiently abundant to cause damage.--Loftin (247).

Trombiculidae

According to unpublished information from McCulloch working on DDT against trombiculid larvae in New Guinea, freshly impregnated garments protect man from attack, but after these garments are washed some larval mites succeed in attaching themselves and bite after the third wash. Larvae allowed to run on cloth freshly impregnated with 1.5 percent of DDT were paralyzed in about 30 minutes. After the cloth had been washed twice in cold water the time was 120 minutes.--Buxton (100).

DDT is of no use as an acaricide.--Simpson (320).

INDEX OF COMMON AND SCIENTIFIC NAMES OF INSECTS